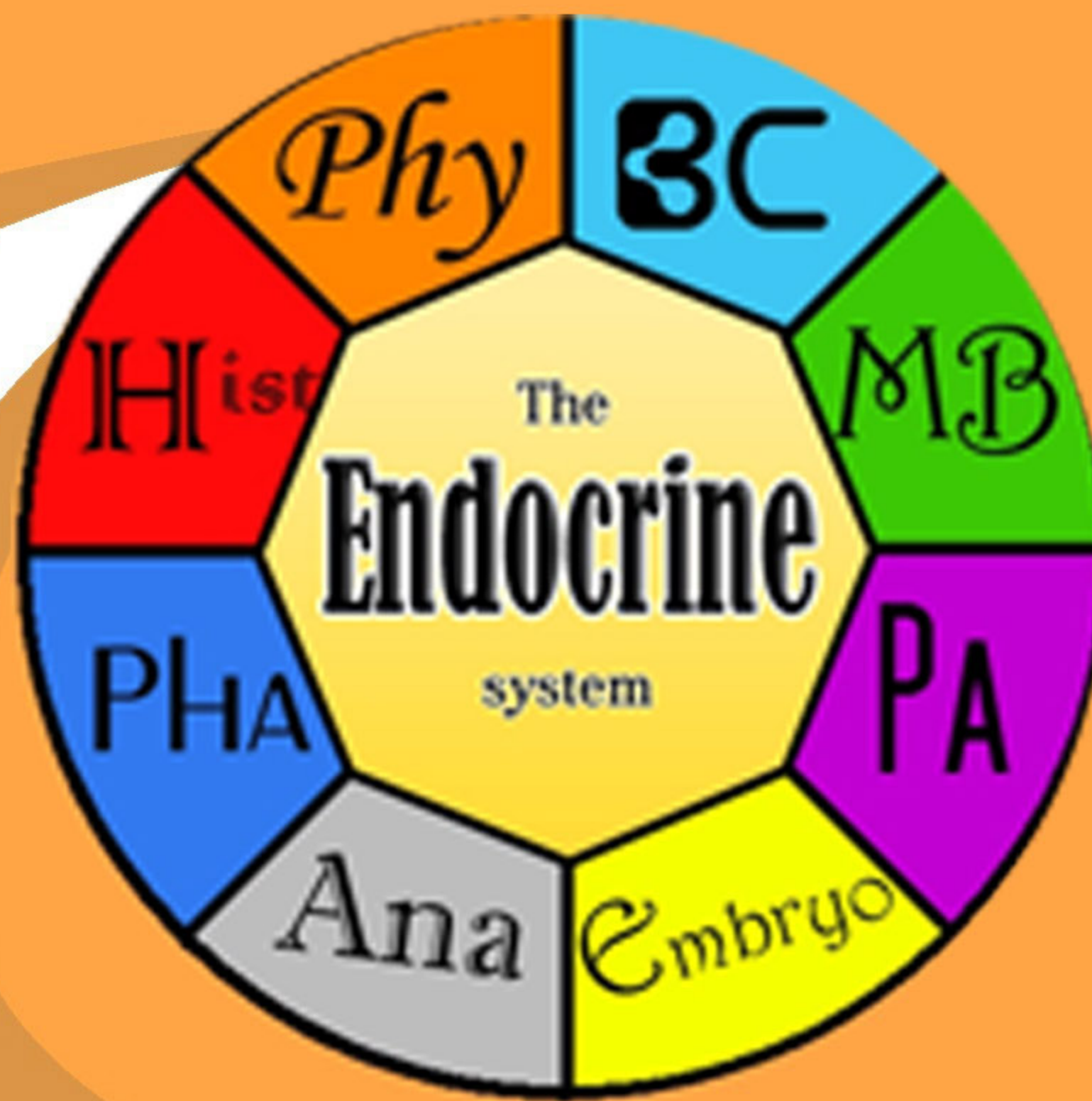




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Title: PITUITARY GLAND

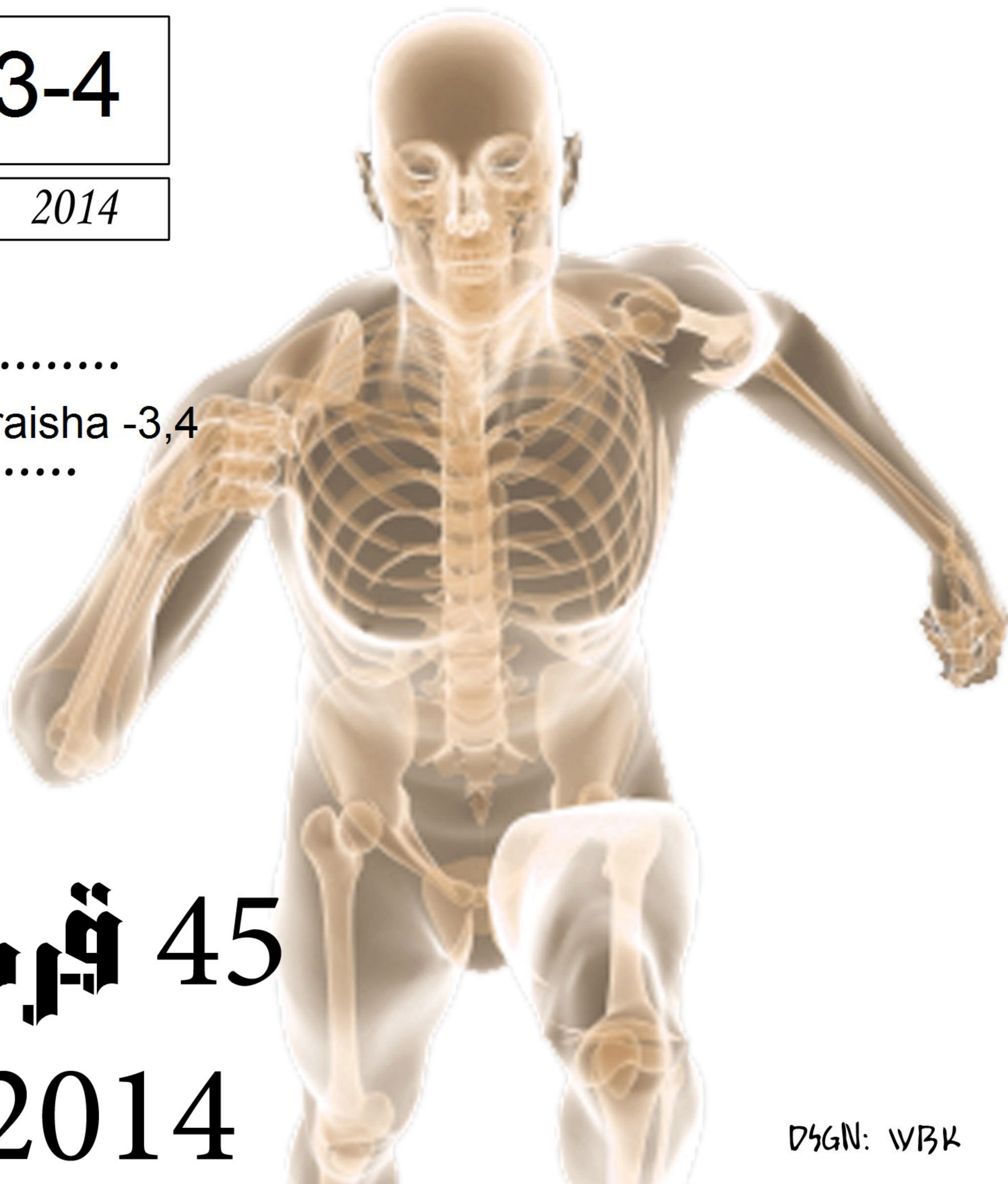
Professor: Dr. Saleem Al-Khraisha -3,4

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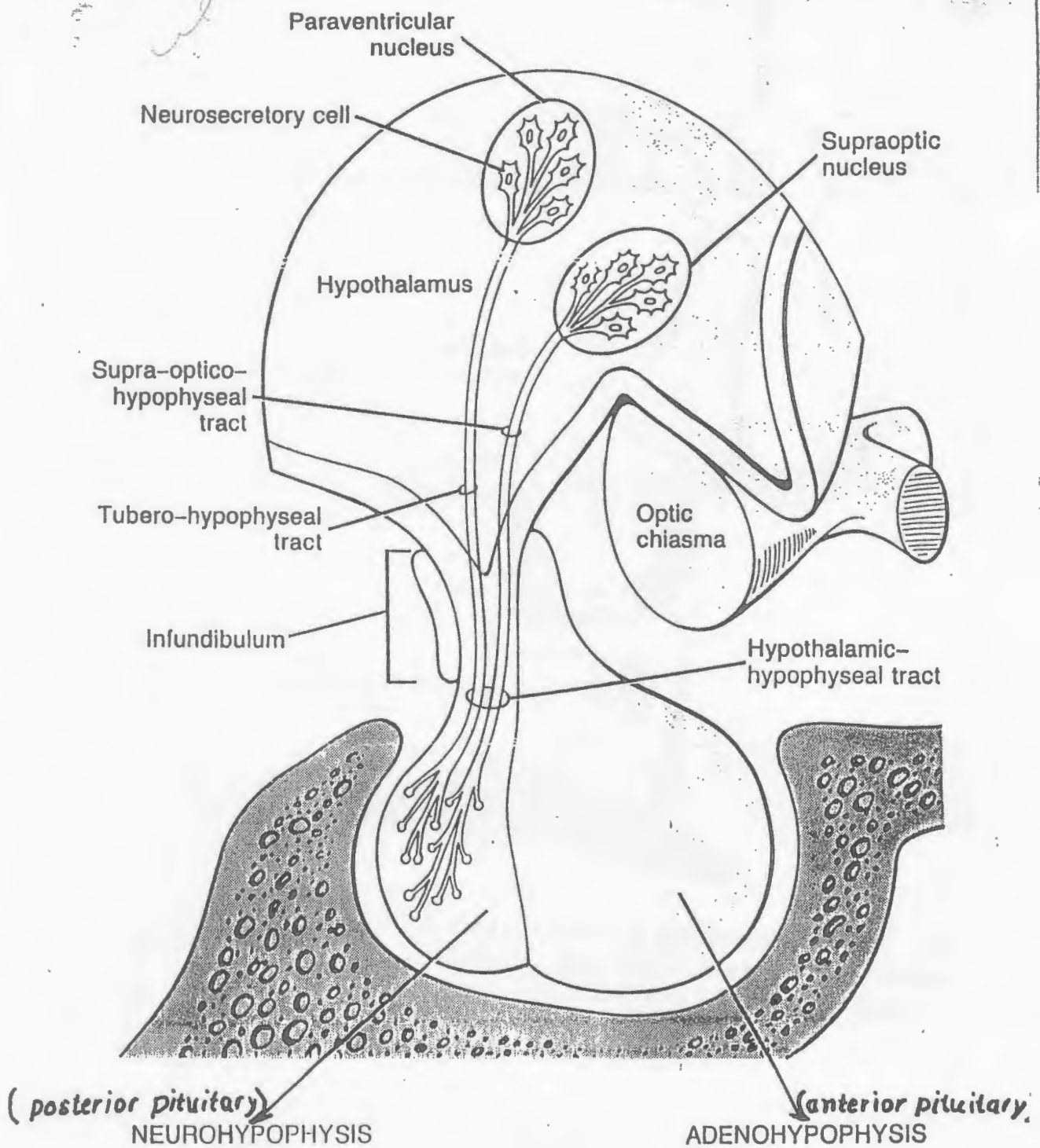


Figure 18-8
Tortora/Anagnostakos: Principles of Anatomy and Physiology, 5/e
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The Pituitary

(hypophysis)

GLAND

small gland—about 1 cm in diameter and 0.5 to 1 gram in weight—that lies in the sella turcica at the base of the brain.

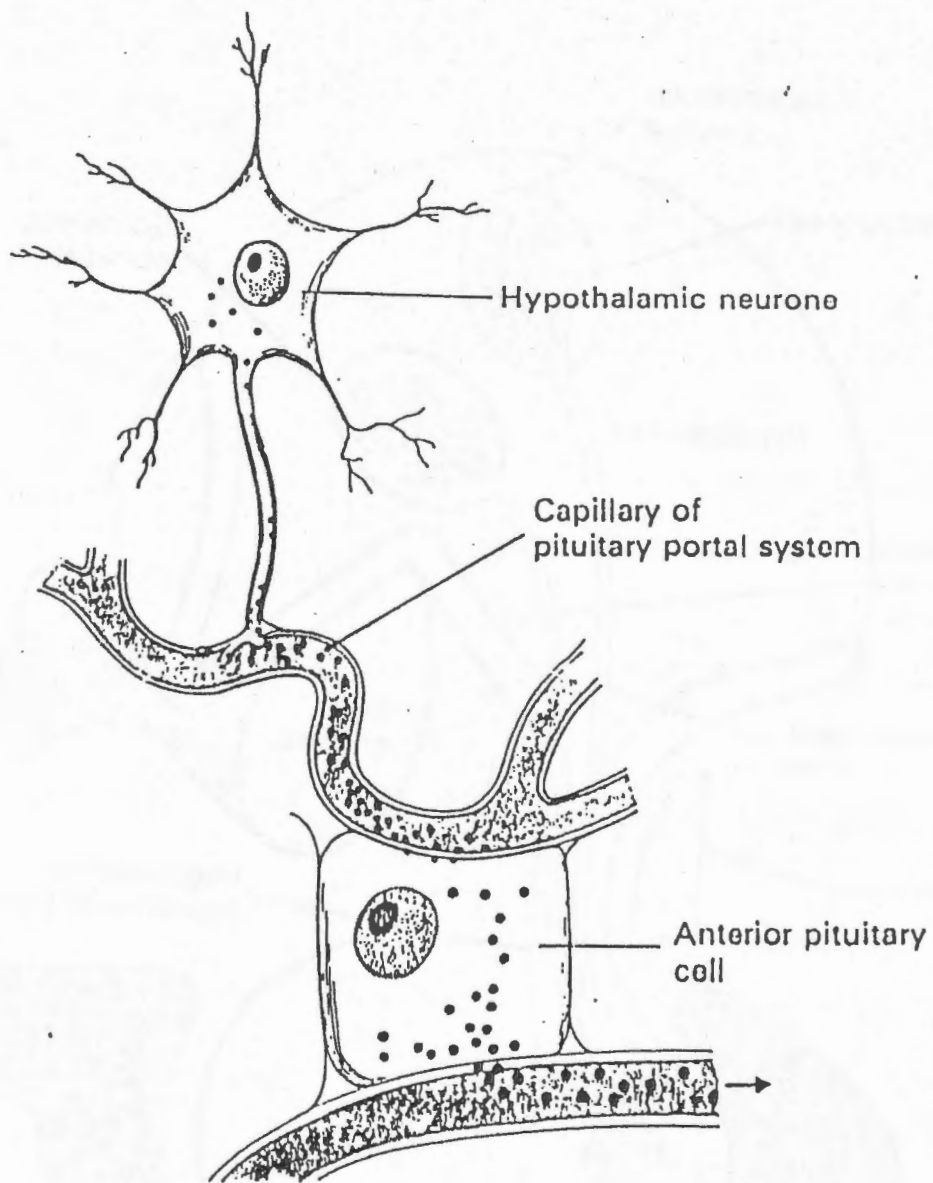


Fig. 28.5 Relationship between hypothalamic neurones and anterior pituitary cells. (From R. Guillemin & R. Burgus (1972) *Scientific American* 227 (5) 24-33.)

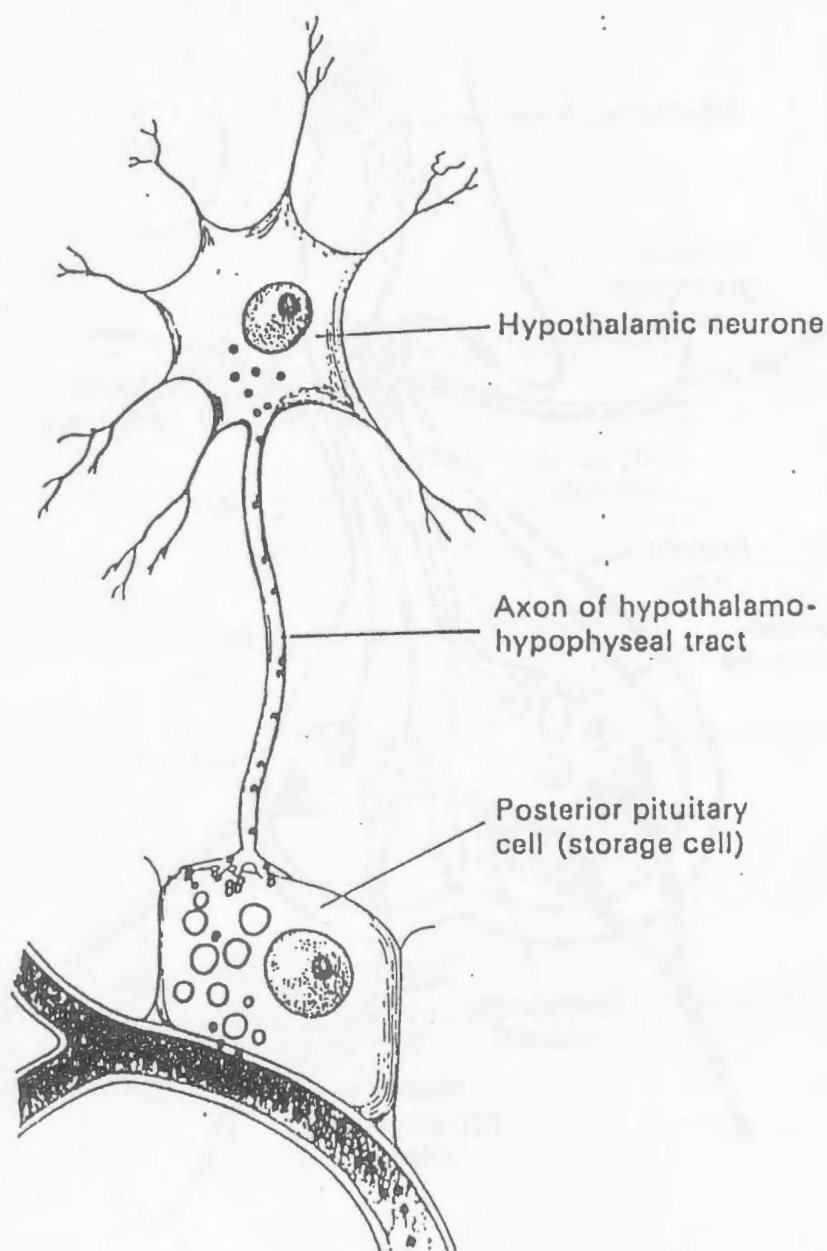


Fig. 28.8 Role of the posterior pituitary cells in the storage of the hormones oxytocin and ADH elaborated by hypothalamic neurones (*From R. Guillemin & R. Burgus (1972) *Scientific American* 227 (5) 24-33.*

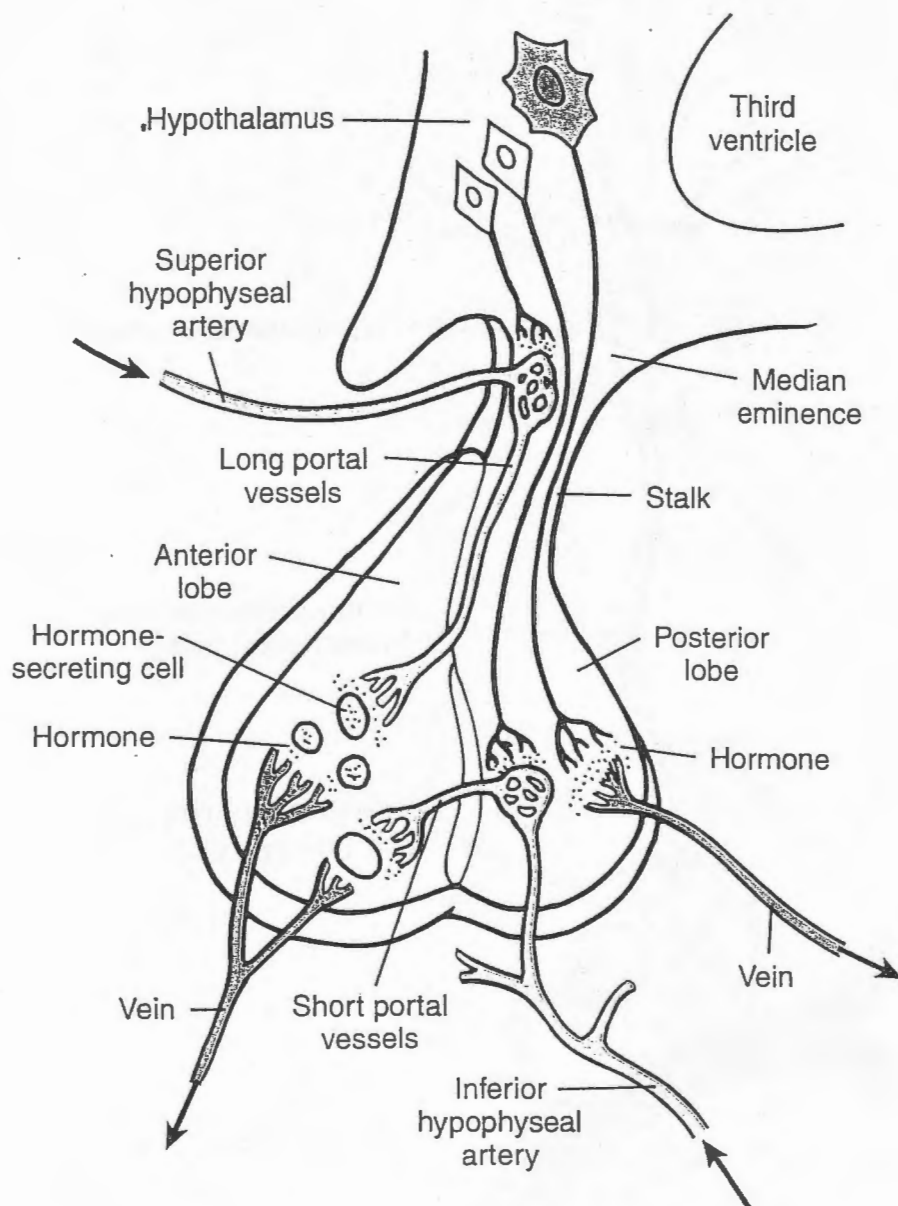


FIGURE 31.2 The blood supply to the anterior pituitary.

This illustration shows the relationship of the pituitary blood supply to hypothalamic magnocellular neurons and to hypothalamic neurosecretory cells that produce releasing hormones. The magnocellular neuron (larger, dark blue cell body) releases AVP or oxytocin at its axon terminals into capillaries that give rise to the venous drainage of the posterior lobe. The neurons with smaller, light blue cell bodies are secreting releasing factors into capillary networks that give rise to the long and short hypophyseal portal vessels, respectively. Releasing hormones are shown reaching the hormone-secreting cells of the anterior lobe via the portal vessels.

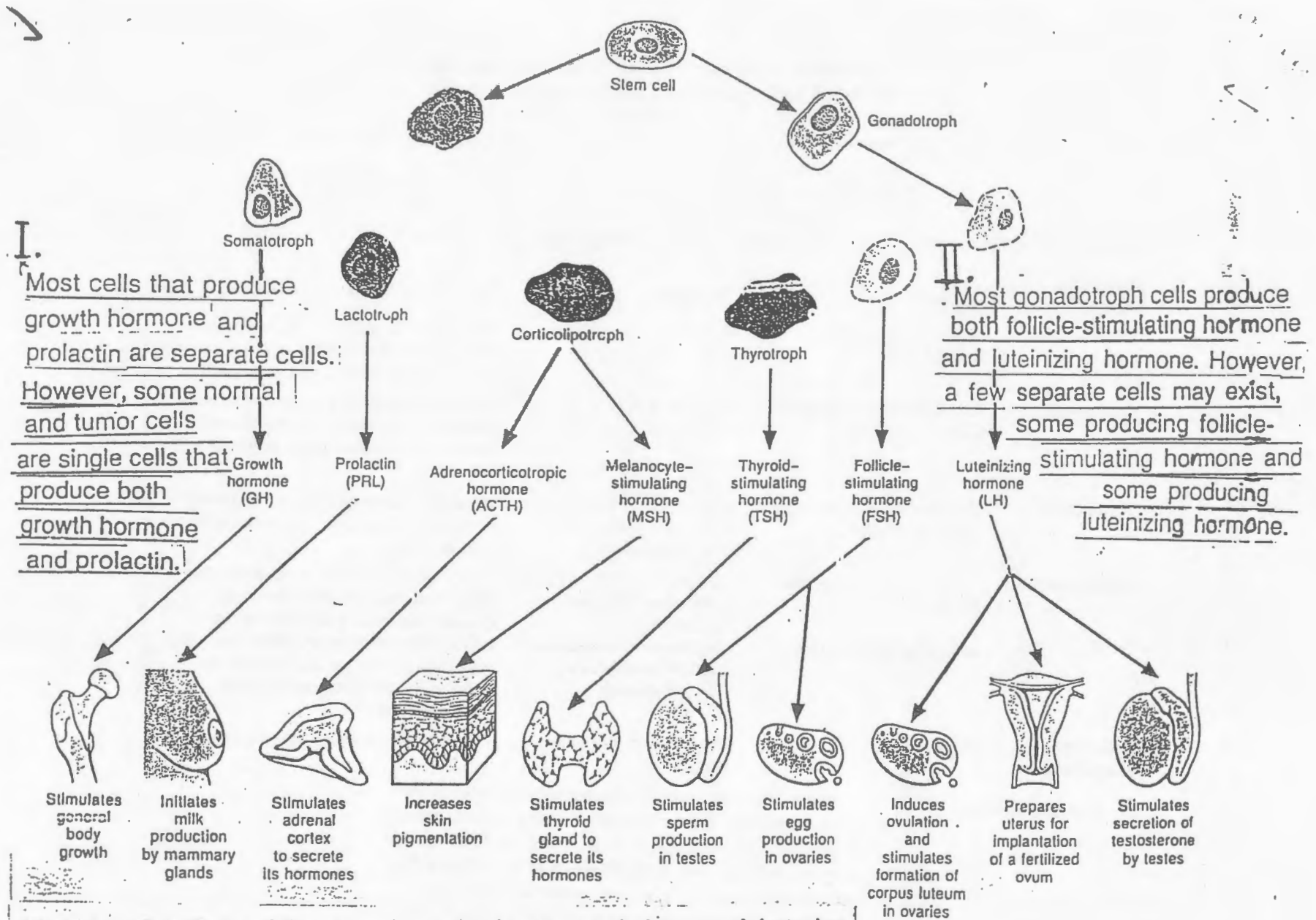


FIGURE 18-6 Cells of the adenohypophysis as revealed by special strains.

Anterior Pituitary Gland Contains Several Different Cell Types That Synthesize and Secrete Hormones. Usually, there is one cell type for each major hormone formed in the anterior pituitary gland. With special stains attached to high-affinity antibodies that bind with the distinctive hormones, at least five cell types can be differentiated.

Table 75-1 Cells and Hormones of the Anterior Pituitary Gland and Their Physiological Functions

Cell	Hormone	Chemistry	Physiological Action
Somatotropes	Growth hormone (GH; somatotropin)	Single chain of 191 amino acids	Stimulates body growth; stimulates secretion of IGF-1; stimulates lipolysis; inhibits actions of insulin on carbohydrate and lipid metabolism
Corticotropes	Adrenocorticotrophic hormone (ACTH; corticotropin)	Single chain of 39 amino acids	Stimulates production of glucocorticoids and androgens by the adrenal cortex; maintains size of zona fasciculata and zona reticularis of cortex
Thyrotropes	Thyroid-stimulating hormone (TSH; thyrotropin)	Glycoprotein of two subunits, α (89 amino acids) and β (112 amino acids)	Stimulates production of thyroid hormones by thyroid follicular cells; maintains size of follicular cells
Gonadotropes	Follicle-stimulating hormone (FSH)	Glycoprotein of two subunits, α (89 amino acids) and β (112 amino acids)	Stimulates development of ovarian follicles; regulates spermatogenesis in the testis
	Luteinizing hormone (LH)	Glycoprotein of two subunits, α (89 amino acids) and β (115 amino acids)	Causes ovulation and formation of the corpus luteum in the ovary; stimulates production of estrogen and progesterone by the ovary; stimulates testosterone production by the testis
Lactotropes	Prolactin (PRL)	Single chain of 198 amino acids	Stimulates milk secretion and production
Mammotropes			

IGF, insulin-like growth factor.

About 30 to 40 percent of the anterior pituitary cells are somatotropes that secrete growth hormone, and about 20 percent are corticotropes that secrete ACTH. Each of the other cell types accounts for only 3 to 5 percent of the total; nevertheless, they secrete powerful hormones for controlling thyroid function, sexual functions, and milk secretion by the breasts.

Specific Areas in the Hypothalamus Control Secretion of Specific Hypothalamic Releasing and Inhibitory Hormones. All or most of the hypothalamic hormones are secreted at nerve endings in the median eminence before being transported to the anterior pituitary

gland. Electrical stimulation of this region excites these nerve endings and, therefore, causes release of essentially all the hypothalamic hormones. However, the neuronal cell bodies that give rise to these median eminence nerve endings are located in other discrete areas of the hypothalamus or in closely related areas of the basal brain.

Table 75-2 Hypothalamic Releasing and Inhibitory Hormones That Control Secretion of the Anterior Pituitary Gland

Hormone	Structure	Primary Action on Anterior Pituitary
Thyrotropin-releasing hormone (TRH)	Peptide of 3 amino acids	Stimulates secretion of TSH by thyrotropes
Gonadotropin-releasing hormone (GnRH)	Single chain of 10 amino acids	Stimulates secretion of FSH and LH by gonadotropes
Corticotropin-releasing hormone (CRH)	Single chain of 41 amino acids	Stimulates secretion of ACTH by corticotropes
Growth hormone-releasing hormone (GHRH)	Single chain of 44 amino acids	Stimulates secretion of growth hormone by somatotropes
Growth hormone inhibitory hormone (somatostatin)	Single chain of 14 amino acids	Inhibits secretion of growth hormone by somatotropes
Prolactin-inhibiting hormone (PIH)	Dopamine (a catecholamine)	Inhibits synthesis and secretion of prolactin by lactotropes

ACTH, adrenocorticotrophic hormone; FSH, follicle-stimulating hormone; LH, luteinizing hormone; TSH, thyroid-stimulating hormone.

For most of the anterior pituitary hormones, it is the releasing hormones that are important, but for prolactin, a hypothalamic inhibitory hormone probably exerts more control.

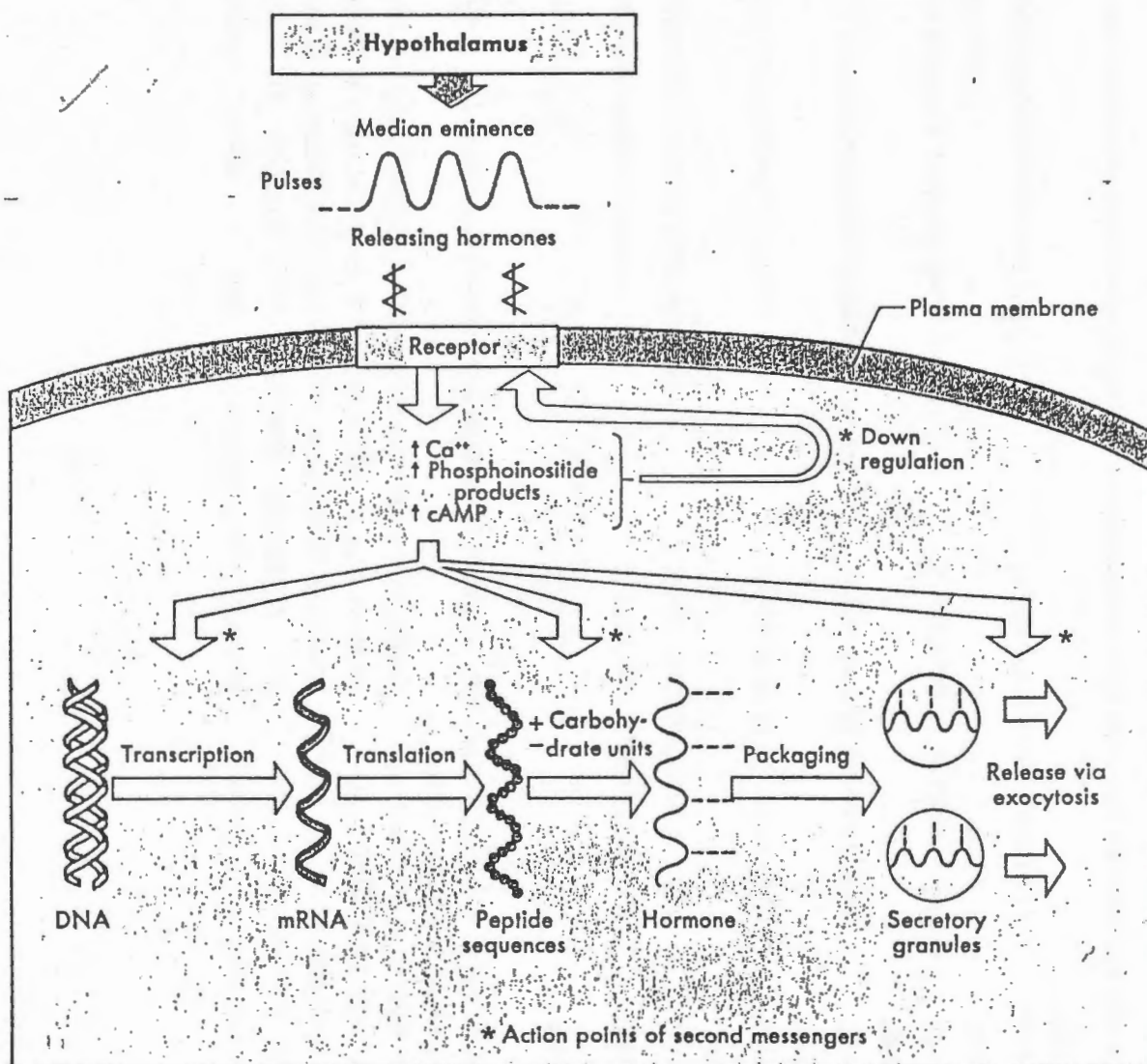


FIGURE 39-3 The action of hypothalamic releasing or inhibiting hormones on anterior pituitary cells. Characteristically the neurohormones are released in pulses, bind to plasma membrane receptors, and act through calcium ions (Ca^{++}) and other second messengers. They regulate gene expression, posttranslational processes, and secretion of anterior pituitary tropic hormones. cAMP, Cyclic adenosine monophosphate; DNA, deoxyribonucleic acid; mRNA, messenger ribonucleic acid.

Vasopressin & Oxytocin

In most mammals, the hormones secreted by the posterior pituitary gland are **arginine vasopressin (AVP)** and **oxytocin**. In hippopotami and most pigs, arginine in the vasopressin molecule is replaced by lysine to form **lysine vasopressin**. The posterior pituitaries of some species of pigs and marsupials contain a mixture of arginine and lysine vasopressin. The posterior lobe hormones are nonapeptides with a disulfide ring at one end (Figure 14-10).

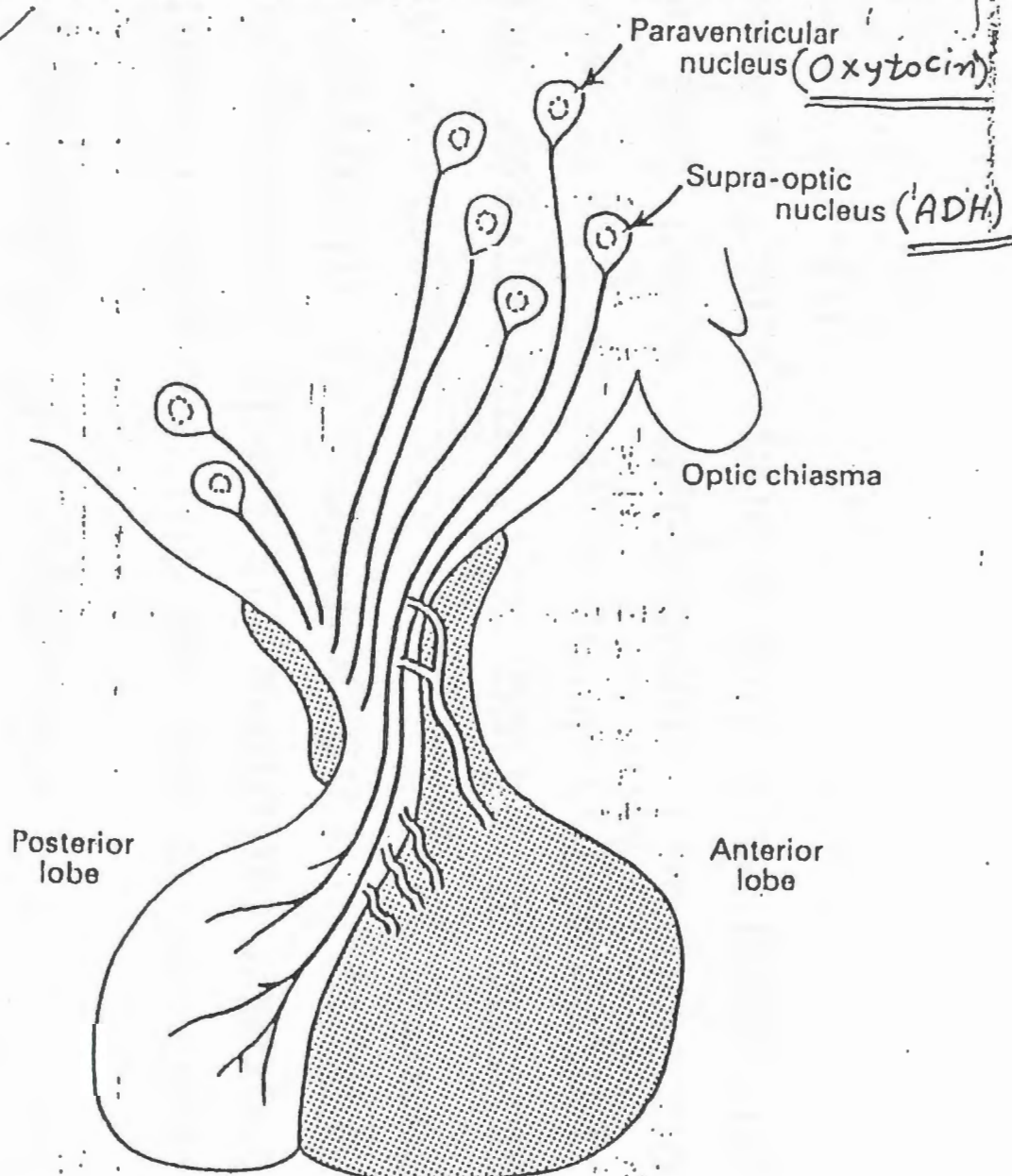


Fig. 28.7 The tracts from the hypothalamus to the pituitary. The paraventricular nucleus and the supra-optic nucleus are thought to be responsible for the elaboration of oxytocin and ADH respectively. The other tracts terminate in the capillary plexus shown in Figure 28.4 and carry the hypothalamic hormones which control the release of the hormones of the anterior pituitary.

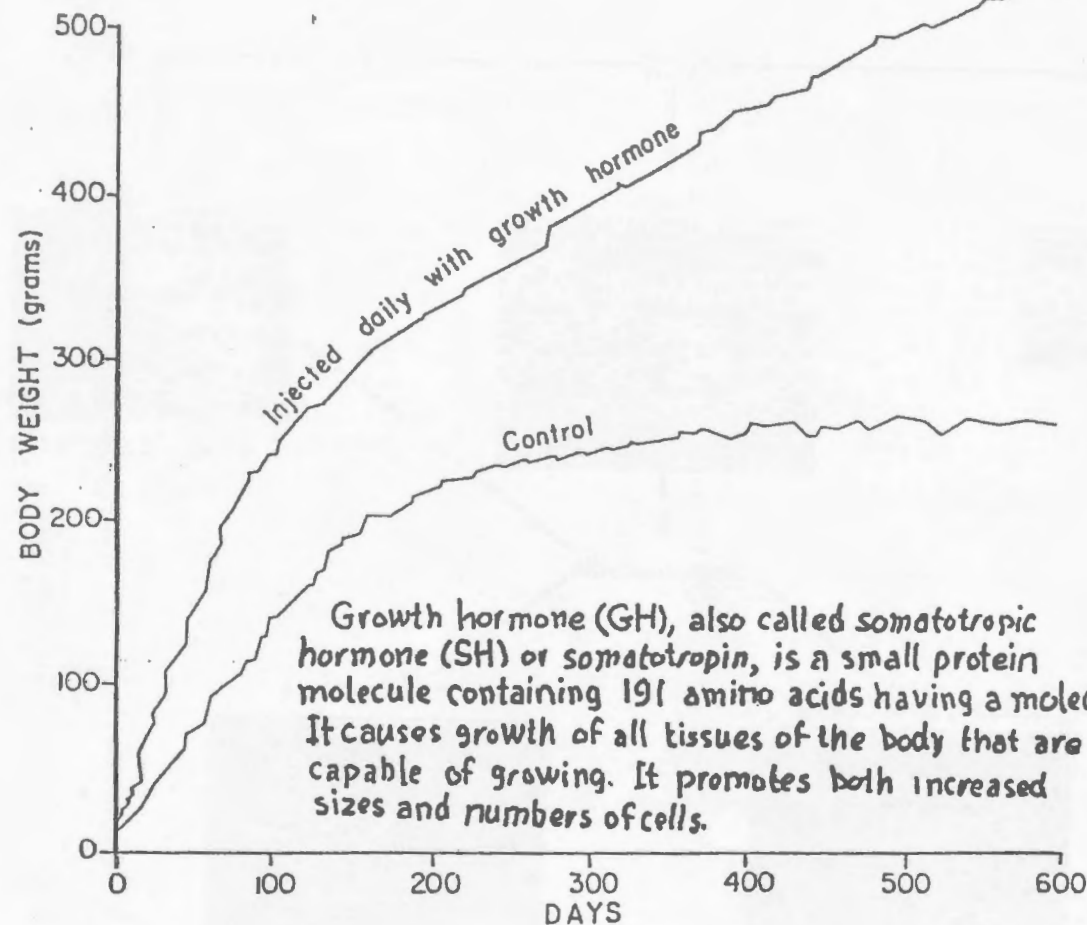
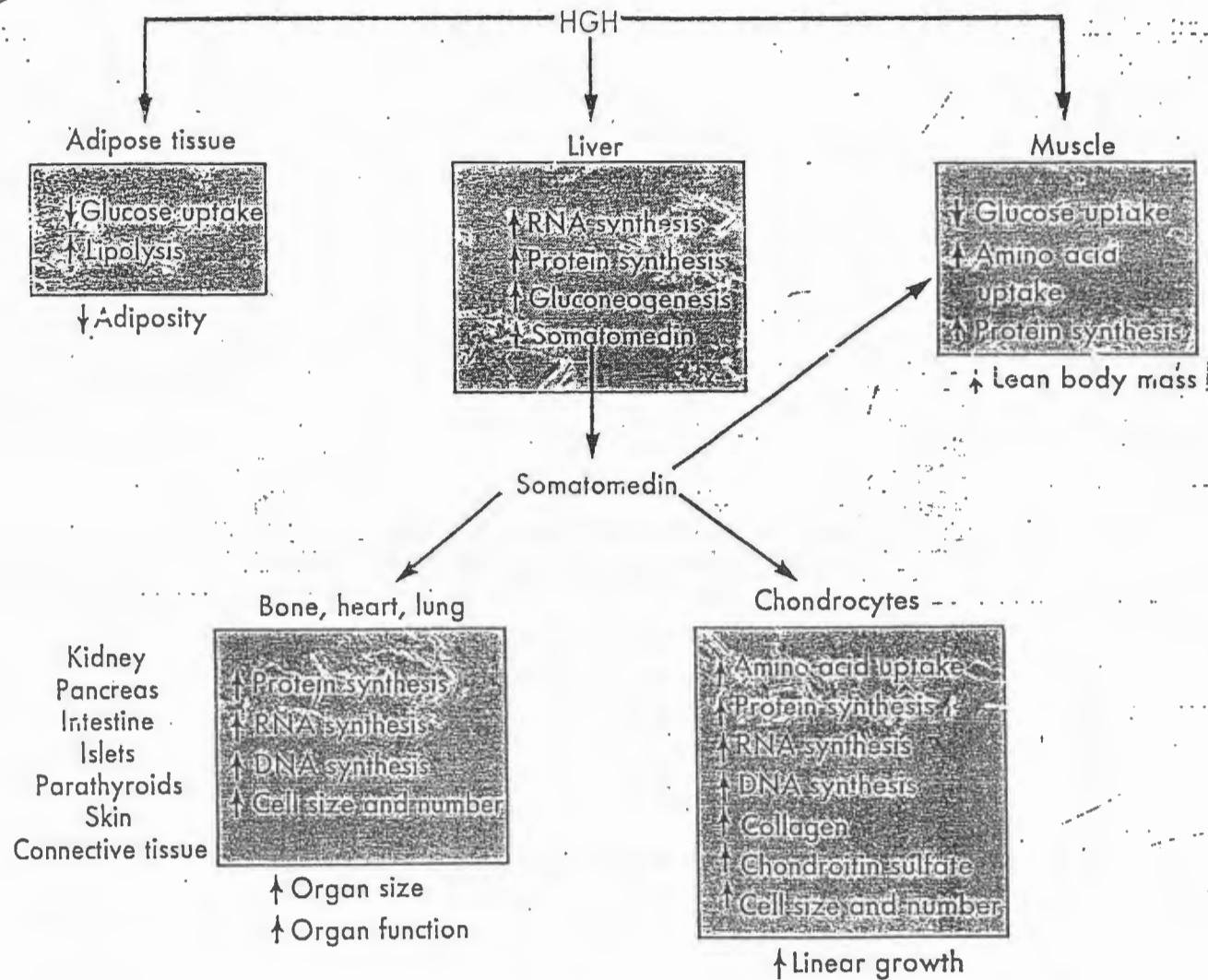


Figure 75-4. Comparison of weight gain of a rat injected daily with growth hormone with that of a normal rat.



■ Fig. 48-21 Biological actions of GH. The effects on linear growth, organ size, and lean body mass are mediated by somatomedin produced in the liver.

EFFECT OF GH IN ENHANCING FAT UTILISATION, FOR ENERGY:

- 1) INCREASES THE RELEASE OF FATTY ACIDS FROM THE ADIPOSE TISSUE.
- 2) FATTY ACIDS CONCENTRATION INCREASES IN BODY FLUIDS.
- 3) IT ENHANCES THE CONVERSION OF FATTY ACIDS INTO ACETYL- C O A., WITH THE SUBSEQUENT UTILISATION FOR ENERGY.
- 4) IN THIS CASE SPARE THE PROTEIN
- 5) UNDER THE EFFECT OF GH THE MOBILISATION OF FAT REQUIRES MINUTES TO HOURS, WHERE AS PROTEIN SYNTHESIS CAN BEGIN IN MINUTES.
- 6) UNDER THE EXCESSIVE OF GH GREAT AMOUNT OF FAT MOBILISED, THEREFORE A LOT OF ACETOACETIC ACIDS ARE FORMED BY THE LIVER AND RELEASED INTO THE BODY FLUIDS, THUS CAUSING (KETOSIS). WHICH IS CALLED "KETOGENIC EFFECT" OF GH.



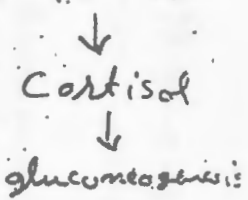
DIABETOGENIC EFFECT OF GH.

- 1) WE HAVE ALREADY MENTIONED THAT GH INCREASES BLOOD GLUCOSE CONCENTRATION.
- 2) IN ADDITION GH MAY HAVE A DIRECT EFFECT ON BETA-CELLS.
- 3) IN THESE CASES PANCREAS OVER STIMULATED AND THE CELLS FINALLY, BURN OUT.
- 4) WHEN THIS OCCURS THE PERSON DEVELOPS DIABETES MELLITUS.
- 5) THEREFORE IS SAID GH HAS DIABETOGENIC EFFECT.

Diabetogenic Effects of Other Anterior Pituitary Hormones. Growth hormone is not the only anterior pituitary hormone that increases the blood glucose concentration. At least three others can do the same: adrenocorticotropin, thyroid-stimulating hormone, and prolactin. Especially important is adrenocorticotropin, which increases the rate of cortisol secretion by the adrenal cortex. Cortisol then increases the blood glucose concentration by increasing the rate of gluconeogenesis.

→ This effect, quantitatively, is probably equally as diabetogenic as the effect of growth hormone.

- 1) TSH
- 2) Prolactin
- 3) ACTH⁺⁺⁺



Growth hormone is secreted in a pulsatile pattern, increasing and decreasing. The precise mechanisms that control secretion of growth hormone are not fully understood, but several factors related to a person's state of nutrition or stress are known to stimulate secretion:

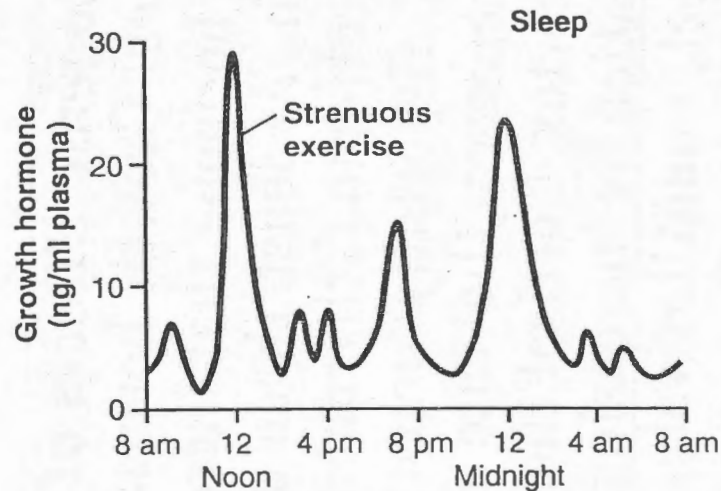


Figure 75-6 Typical variations in growth hormone secretion throughout the day, demonstrating the especially powerful effect of strenuous exercise and also the high rate of growth hormone secretion that occurs during the first few hours of deep sleep.

Table 75-3 Factors That Stimulate or Inhibit Secretion of Growth Hormone

Stimulate Growth Hormone Secretion

- Decreased blood glucose
- Decreased blood free fatty acids
- Increased blood amino acids (arginine)
- Starvation or fasting, protein deficiency
- Trauma, stress, excitement
- Exercise
- Testosterone, estrogen
- Deep sleep (stages II and IV)
- Growth hormone-releasing hormone
- Ghrelin

Inhibit Growth Hormone Secretion

- Increased blood glucose
- Increased blood free fatty acids
- Aging
- Obesity
- Growth hormone inhibitory hormone (somatostatin)
- Growth hormone (exogenous)
- Somatomedins (insulin-like growth factors)

● *ghrelin*, a hormone secreted by the stomach before meals.

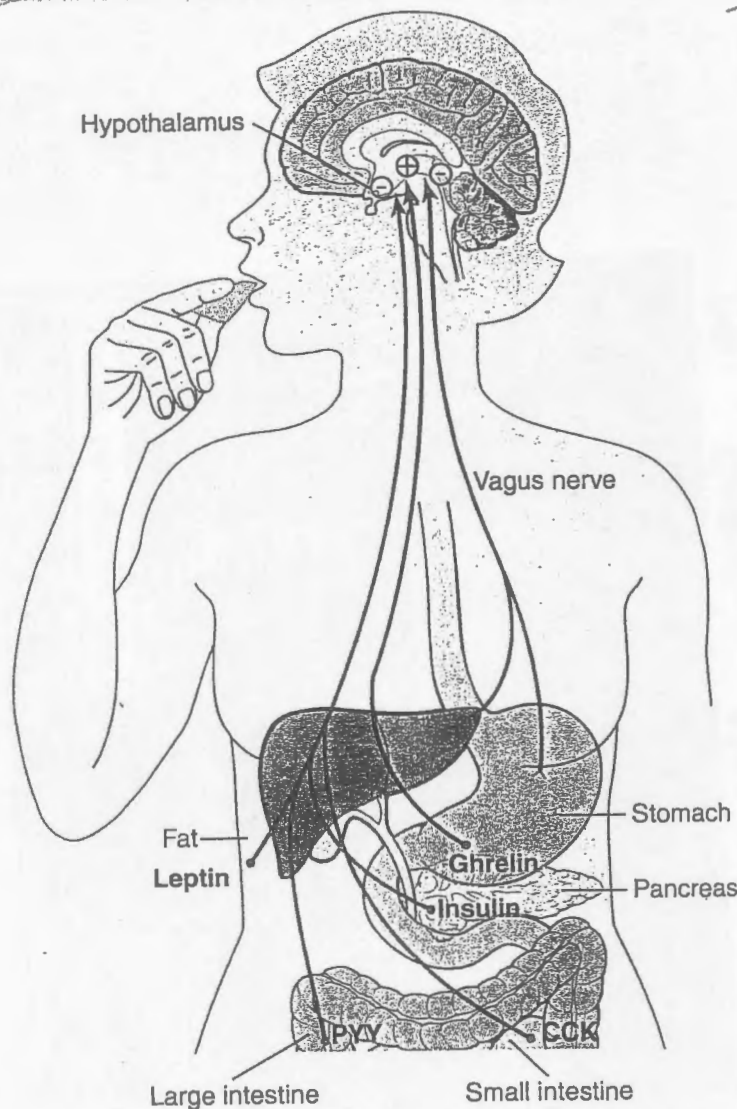
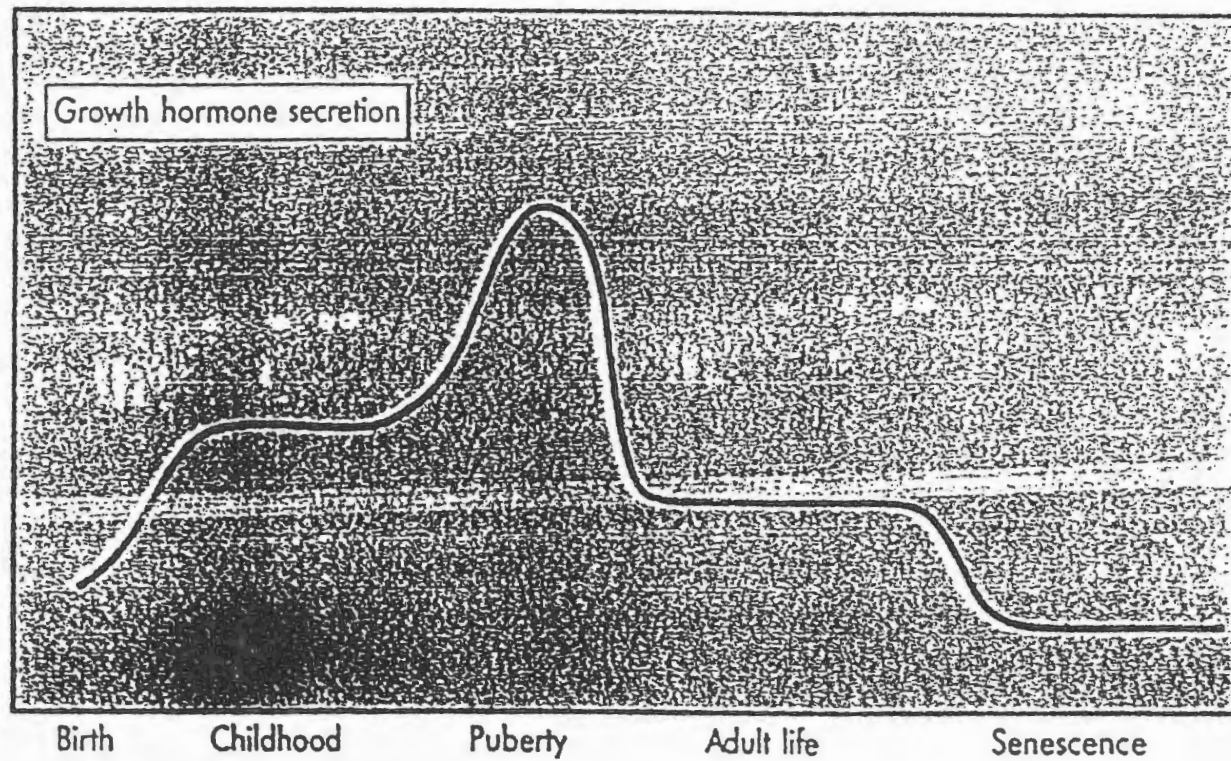
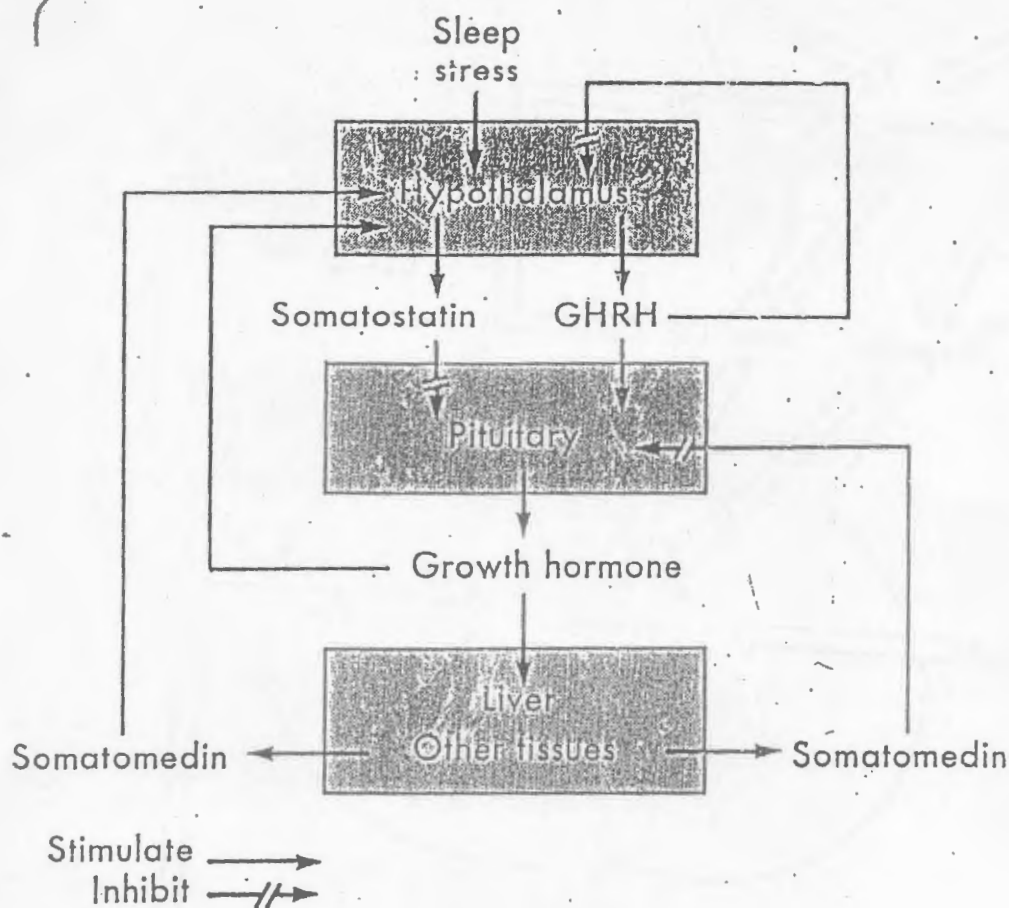


Figure 71-1 Feedback mechanisms for control of food intake. Stretch receptors in the stomach activate sensory afferent pathways in the vagus nerve and inhibit food intake. Peptide YY (PYY), cholecystokinin (CCK), and insulin are gastrointestinal hormones that are released by the ingestion of food and suppress further feeding. Ghrelin is released by the stomach, especially during fasting, and stimulates appetite. Leptin is a hormone produced in increasing amounts by fat cells as they increase in size; it inhibits food intake.

→ Ghrelin—a Gastrointestinal Hormone—Increases Feeding. *Ghrelin* is a hormone released mainly by the oxyntic cells of the stomach but also, to a much less extent, by the intestine. Blood levels of ghrelin rise during fasting, peak just before eating, and then fall rapidly after a meal, suggesting a possible role in stimulating feeding. Also, administration of ghrelin increases food intake in experimental animals, further supporting the possibility that it may be an orexigenic hormone. However, its physiologic role in humans is still uncertain.



■ Fig. 48-19 Lifetime pattern of growth hormone (GH) secretion. GH levels are higher in children than adults with a peak period during puberty. GH secretion declines with aging.



■ Fig. 48-20 Regulation of growth hormone (GH) secretion. The hypothalamic peptide (GHRH) stimulates growth hormone release, whereas the hypothalamic peptide somatostatin inhibits it. Negative feedback is by the peripheral mediator of HGH action: somatomedin. Negative feedback occurs both via somatomedin inhibition of GHRH action and by somatomedin stimulation of somatostatin release. HGH inhibits its own secretion by short-loop feedback. In addition GHRH inhibits its own release via ultra short-loop feedback. In both of these cases the negative feedback is, probably via increasing somatostatin release.

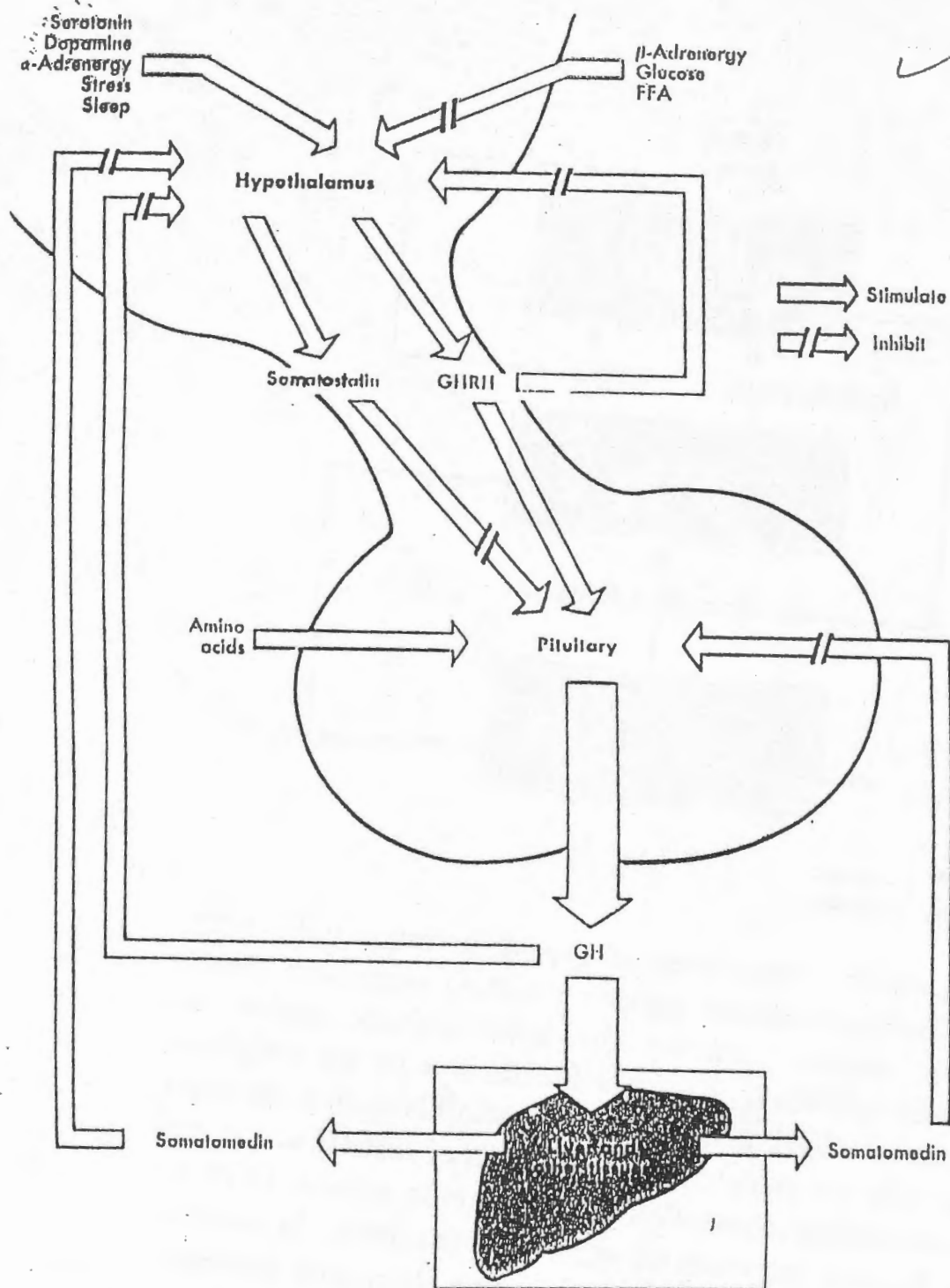
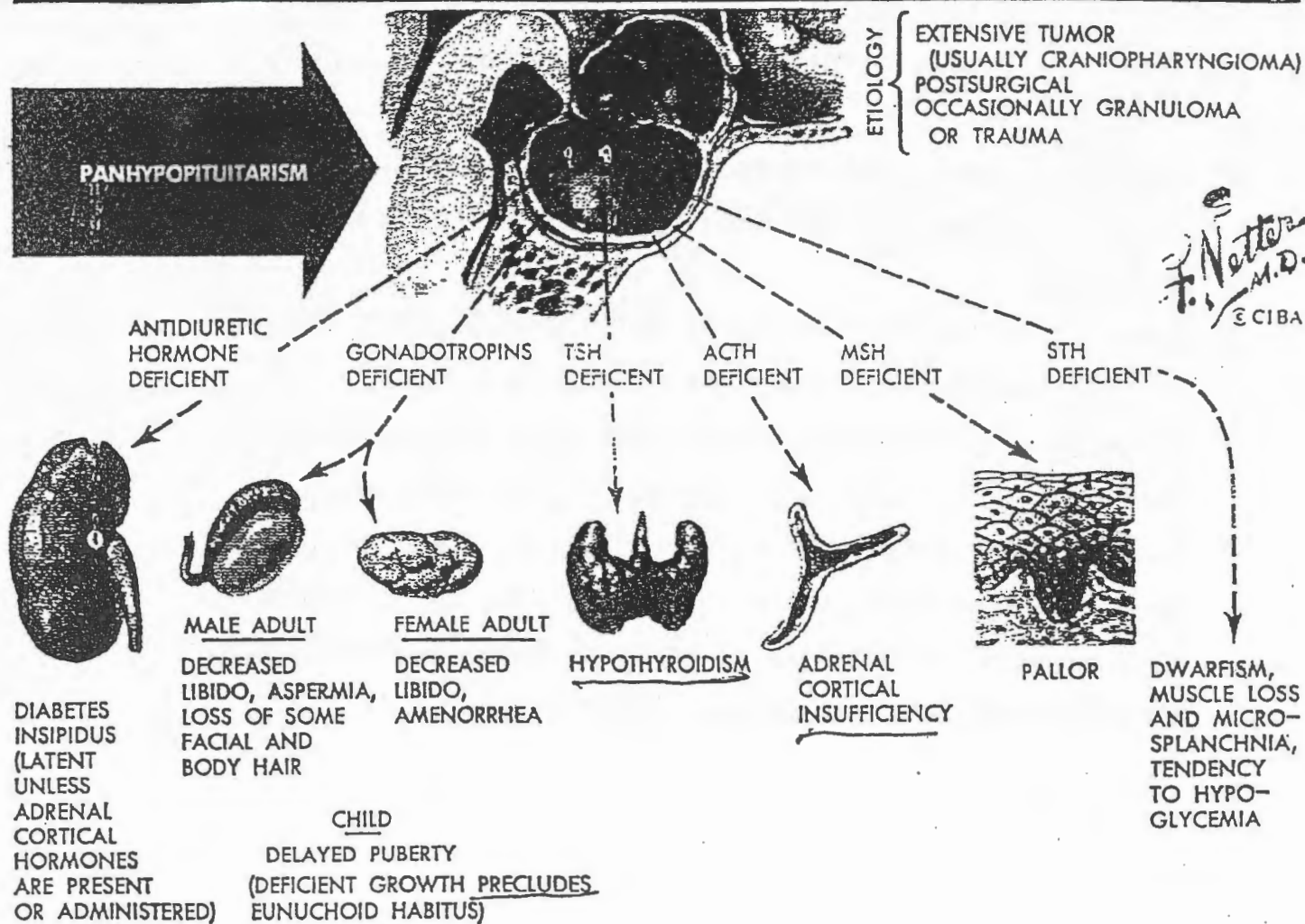
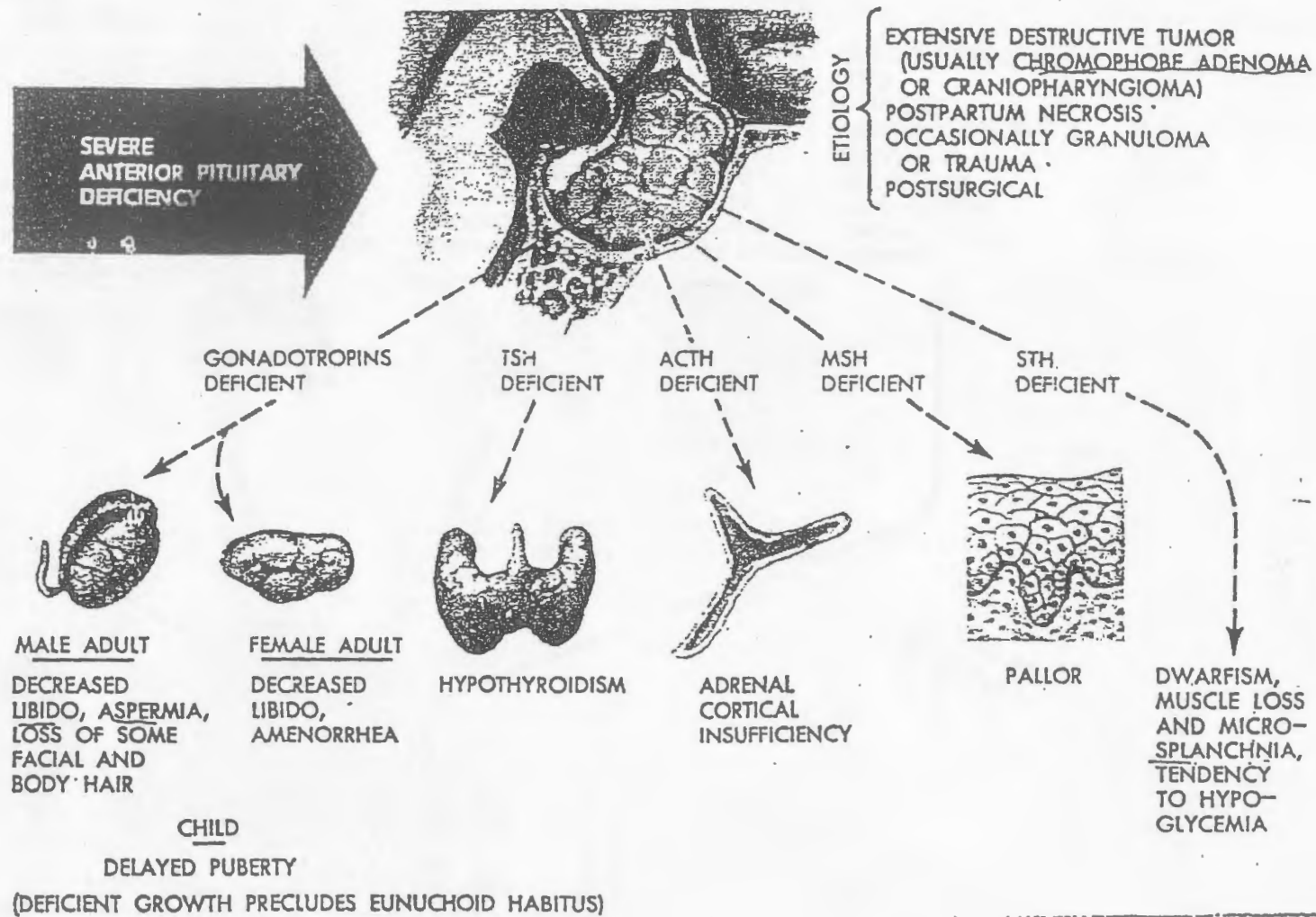


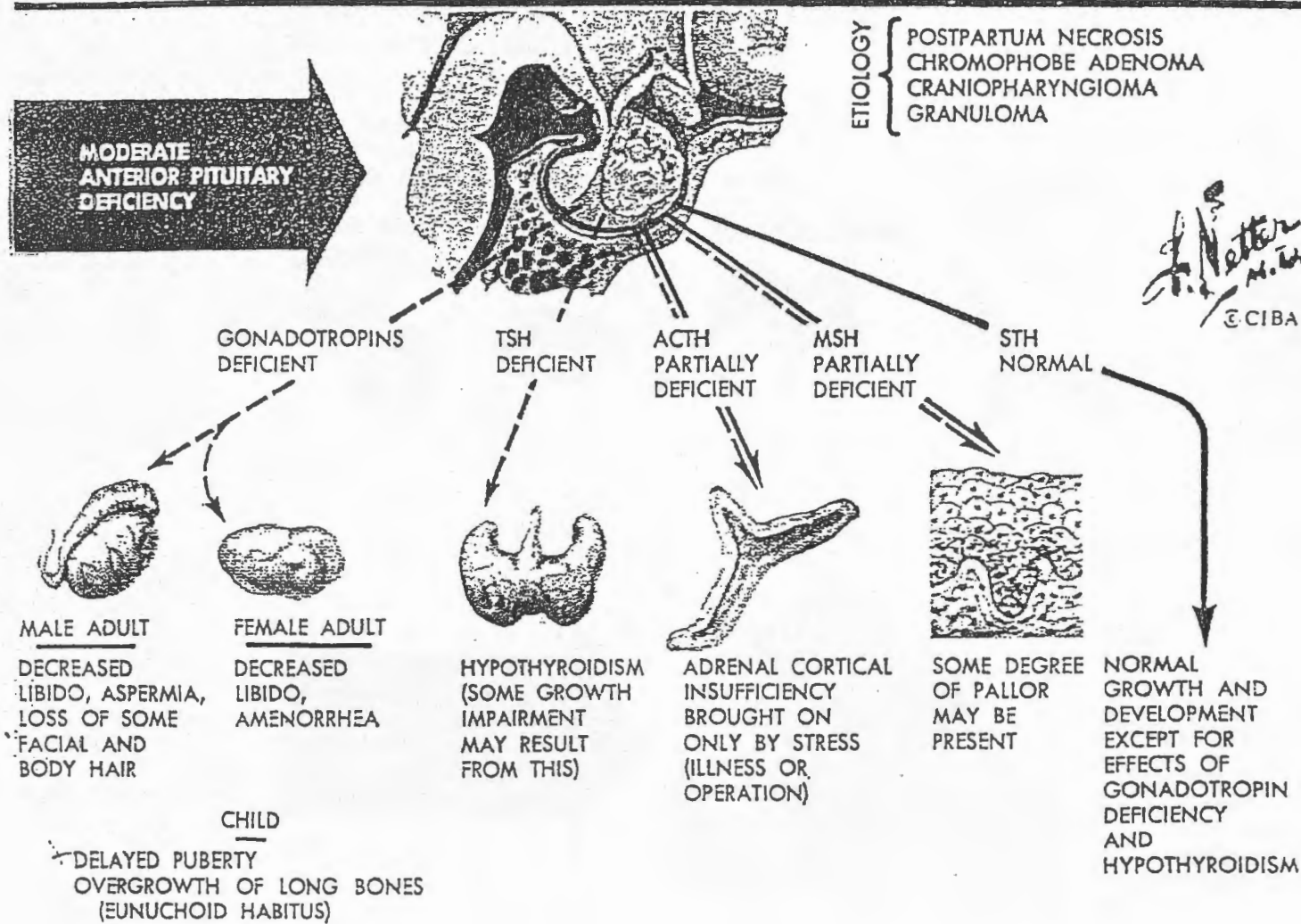
FIGURE 39-10 Regulation of GH secretion. Note both a direct stimulatory and a direct inhibitory influence from the hypothalamus. Negative feedback by the peripheral product is exerted at the hypothalamic and the pituitary level. *GHRH*, Growth hormone-releasing hormone; *FFA*, free fatty acids.

EFFECTS OF HYPOPHYSECTOMY. Several notable morphological and functional alterations result from total hypophysectomy in the young animal. These are as follows:

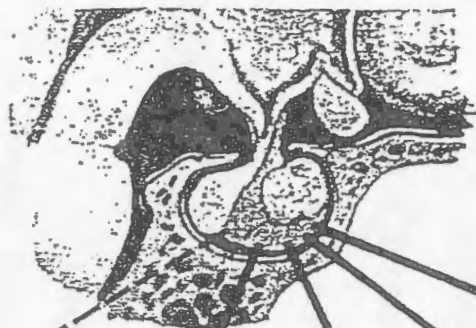
1. Failure of the gonads to mature, with resultant infantile sexual development and sterility because of lack of LH and FSH.
2. Atrophy of the thyroid gland and the characteristics of thyroid insufficiency because of lack of TSH.
3. Atrophy of the adrenal cortex and signs of hypoadrenalism without salt loss because of ACTH deficiency.
4. Cessation of growth, failure to attain an adult stature, a decided tendency toward hypoglycemia, hypersensitivity to insulin, and a loss of body nitrogen accompanied by diminished fat catabolism because of lack of STH.







**MILD
ANTERIOR PITUITARY
DEFICIENCY**



ETIOLOGY

- POSTPARTUM NECROSIS
- CHROMOPHOBE ADENOMA†
- CRANIOPHARYNGIOMA
- CONGENITAL LACK OF DELTA CELLS ("GONADOTROPHS")
- GRANULOMA

GONADOTROPINS
DEFICIENT

TSH
NORMAL

ACTH
NORMAL

MSH
NORMAL

STH
NORMAL



MALE ADULT

DECREASED
LIBIDO, ASPERMIA,
LOSS OF SOME
FACIAL AND
BODY HAIR



FEMALE ADULT

DECREASED
LIBIDO,
AMENORRHEA



THYROID
FUNCTION
NORMAL



ADRENAL CORTICAL
FUNCTION NORMAL



NORMAL
PIGMENTATION

CHILD
DELAYED PUBERTY
OVERGROWTH OF LONG BONES
(EUNUCHOID HABITUS)

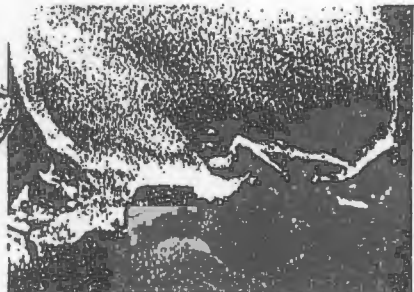
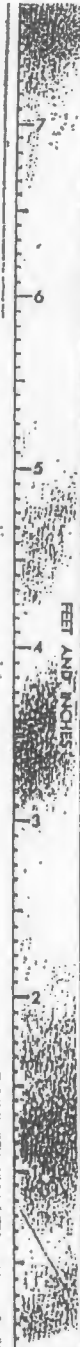
NORMAL
GROWTH
AND
DEVELOPMENT
EXCEPT FOR
EFFECTS OF
GONADOTROPIN
DEFICIENCY

Giantism (Gigantism):- If G.H. Producing

cells tumour occurs before adolescence, all body tissues will grow rapidly including the bones, because the epiphyses of the long bones have not fused with the shafts.

- 1- Their heights 8-9 feet
- 2- The giants have hyperglycemia, 10% develop diabetes mellitus.
- 3- If the giants remain without treatment will develop pan-hyp.

GIGANTISM



X-RAY OF TUMOR
PROTRUDING ABOVE
TUBERCULUM SELLAE
OUTLINED BY AIR

PITUITARY GIANT
CONTRASTED WITH
NORMAL MAN
(ACROMEGALY
AND SIGNS OF
SECONDARY PITUITARY
INSUFFICIENCY
MAY OR MAY NOT
BE PRESENT)

J. Netter M.D.
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Acromegaly:- If tumour occurs after adolescence, after the fusion of the long bones. The person can not grow taller, but the soft tissues can continue growing and the bones can grow in thickness.

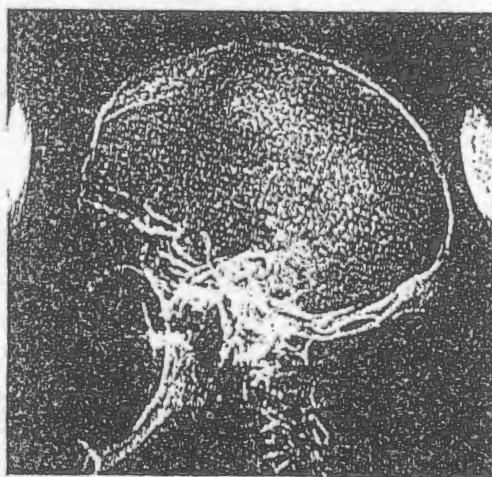
- 1- Enlargement marked in the small bones of the hands and feet and also the craniums, nose, forehead, supraorbital ridges, the lower jaw bones and the portions of the vertebrae.
- 2- Finally, many soft tissues or organs like liver, tongue, kidneys become greatly enlarged.

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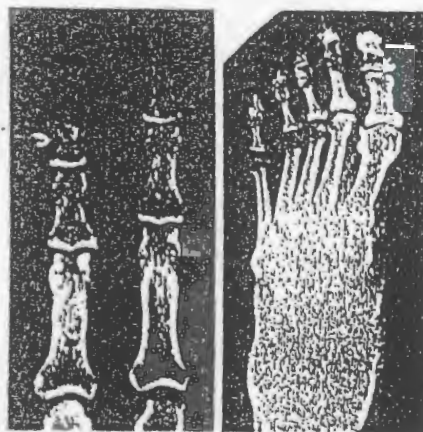
ACROMEGALY



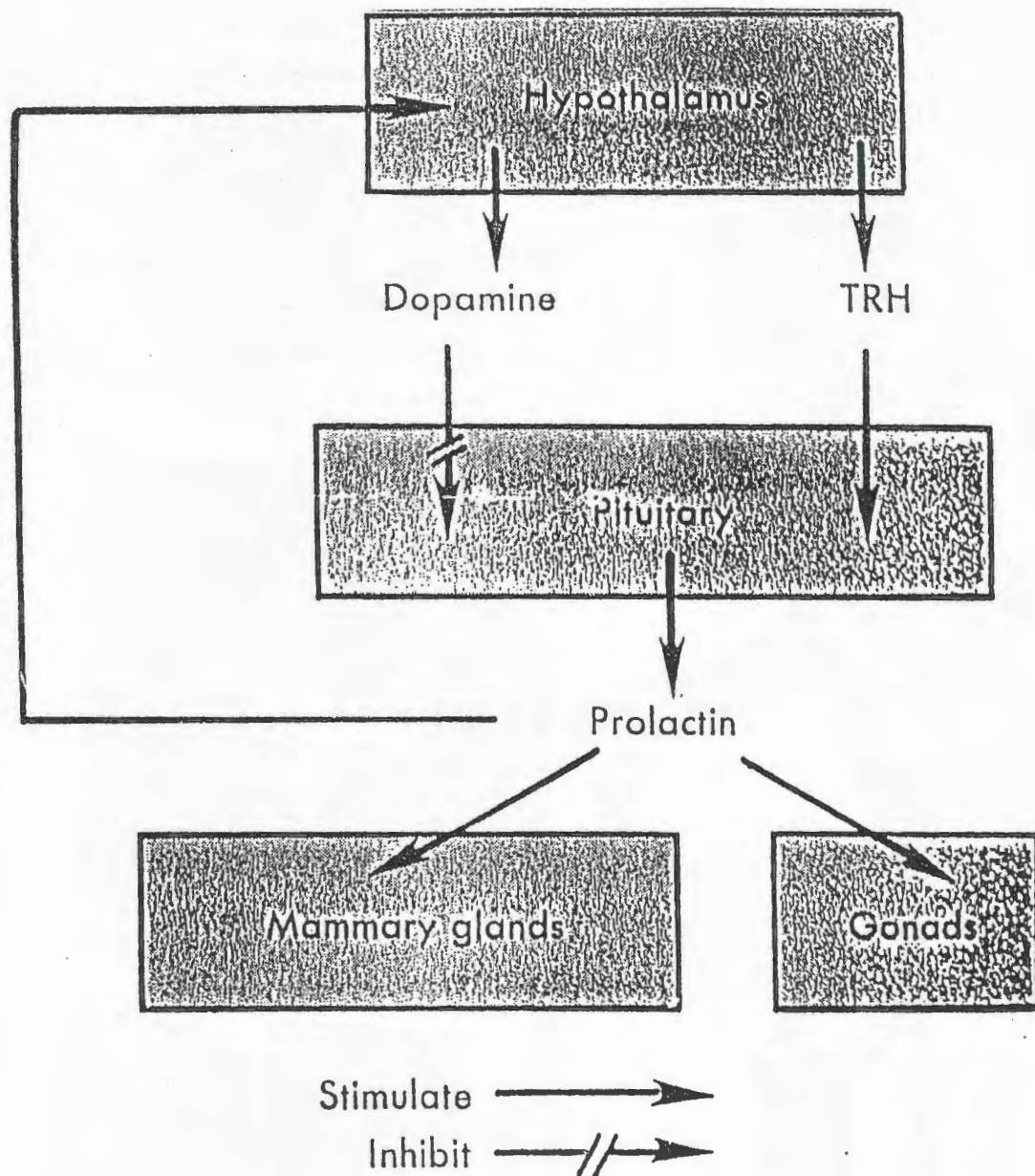
THORACIC VERTEBRA IN ACROMEGALY: HYPEROSTOSIS, ESPECIALLY MARKED ON ANTERIOR ASPECT



X-RAY OF SKULL IN ACROMEGALY: ENLARGEMENT OF SELLA TURCICA, WITH OCCIPITAL PROTUBERANCE, THICKENING OF CRANIAL BONES, ENLARGEMENT OF SINUSES AND OF MANDIBLE



TUFTING OF PHALANGES IN HANDS AND NARROWING OF PHALANGES IN FEET



■ Fig. 52-25. Regulation of prolactin secretion. The predominant mode of hypothalamic regulation is tonic inhibition via dopamine. Although TRH stimulates prolactin release, its physiological role is uncertain, and evidence suggests another hypothalamic peptide may be more physiologically important. Prolactin exerts short-loop feedback on its own secretion by stimulating production of the hypothalamic inhibitor, dopamine.

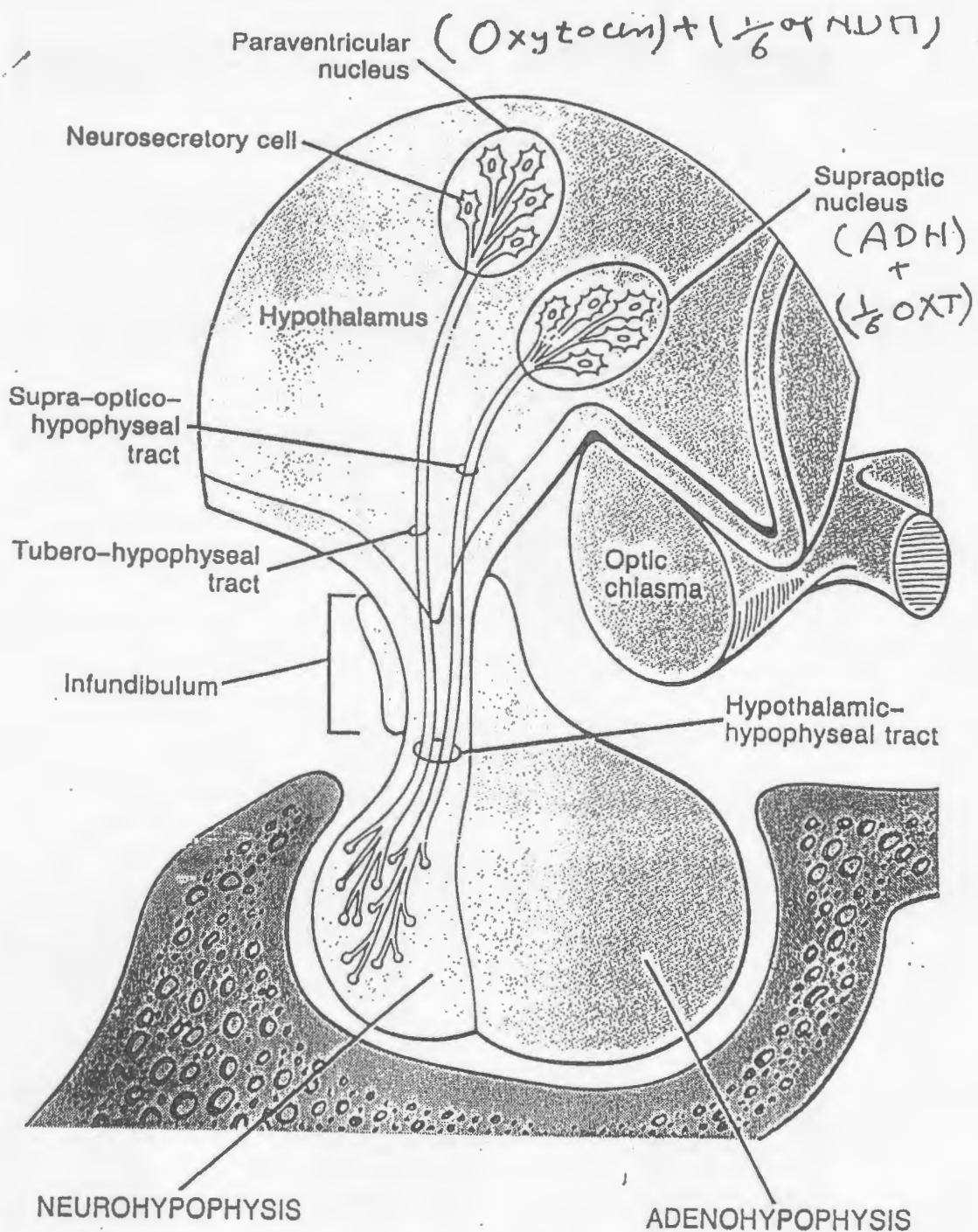


Figure 10-8
 Tortora/Anagnostakos: Principles of Anatomy and Physiology, 5/e
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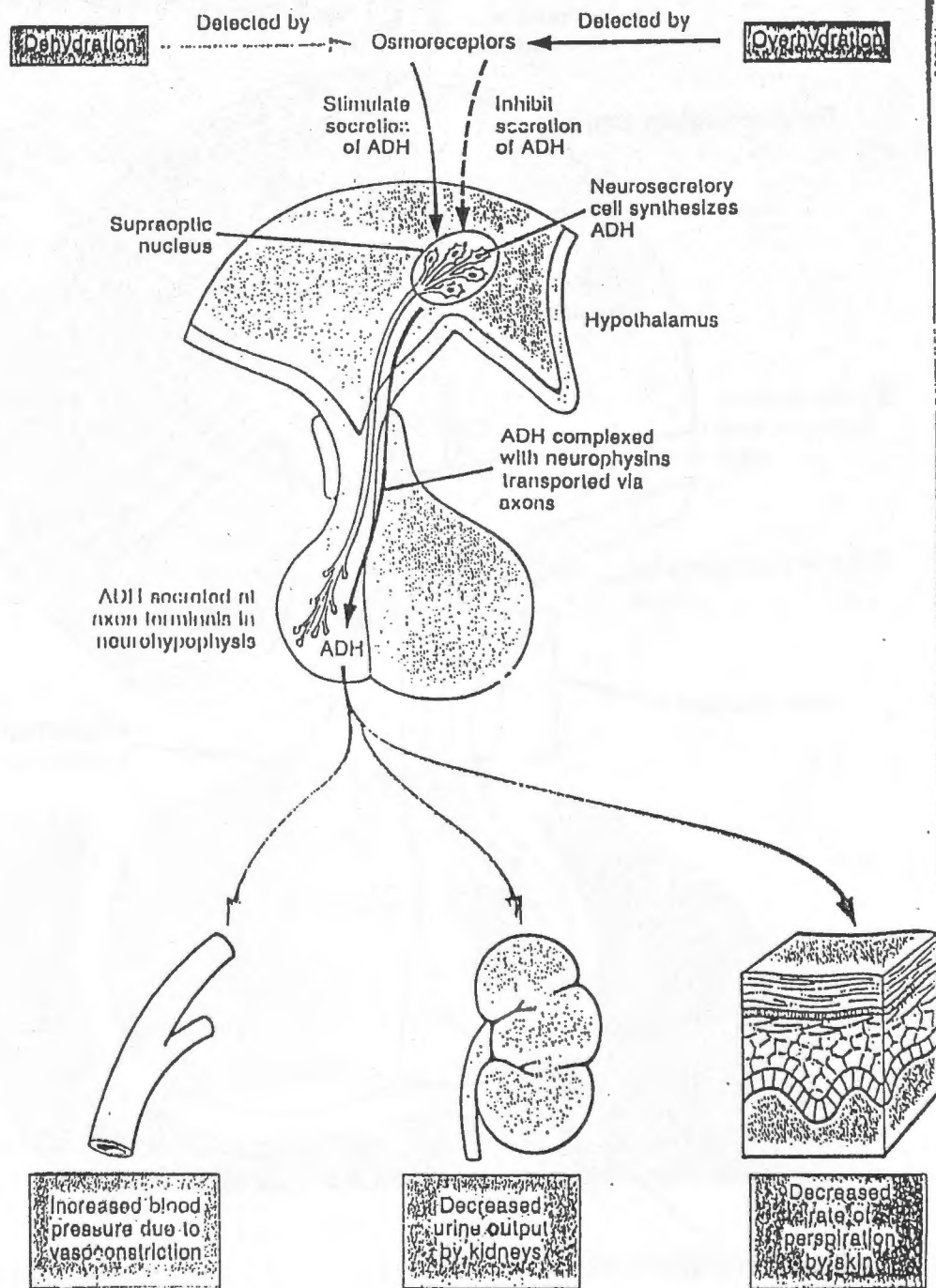


FIGURE 10-10 Regulation of the secretion of antidiuretic hormone (ADH).

Vasopressin & Oxytocin

In most mammals, the hormones secreted by the posterior pituitary gland are **arginine vasopressin (AVP)** and **oxytocin**. In hippopotami and most pigs, arginine in the vasopressin molecule is replaced by lysine to form **lysine vasopressin**. The posterior pituitaries of some species of pigs and marsupials contain a mixture of arginine and lysine vasopressin. The posterior lobe hormones are nonapeptides with a disulfide ring at one end (Figure 14-10).

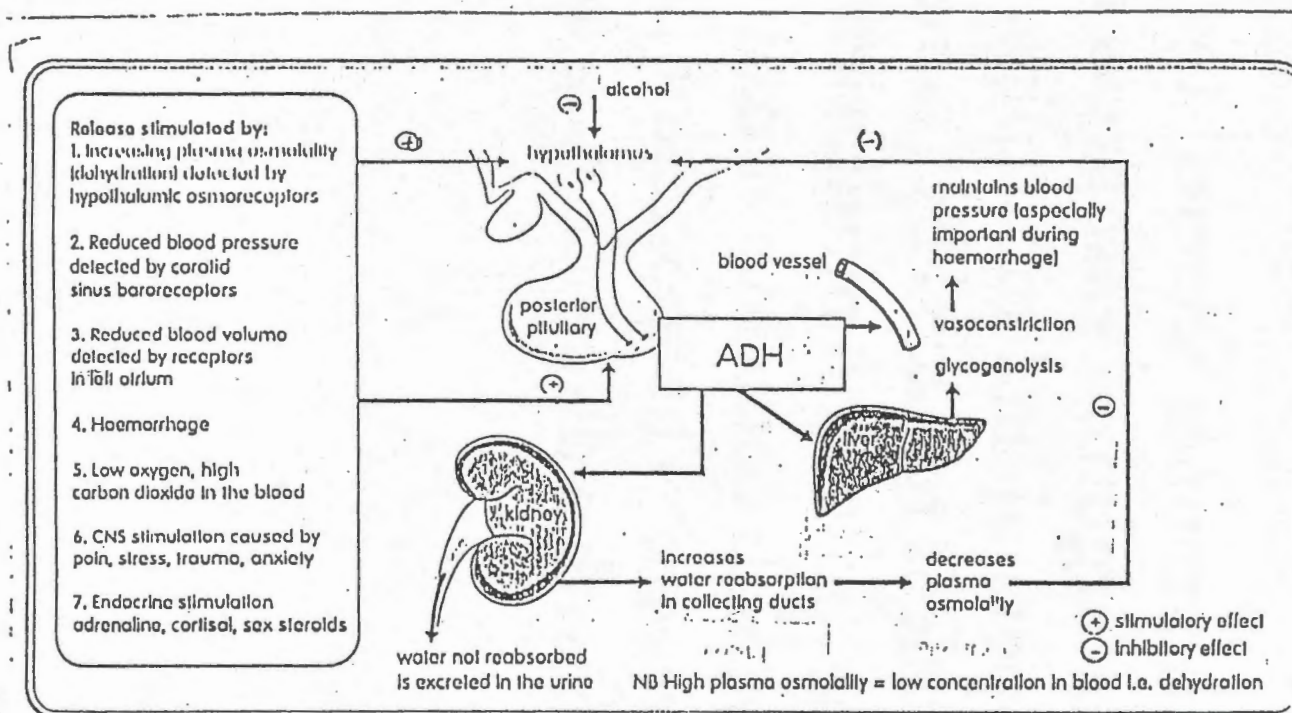


Fig. 7.5 The control of ADH secretion and its actions on the kidney, liver, and blood vessels.

Fig. 30-4. Factors that regulate the secretion of ADH by the hypothalamoneurohypophyseal system (HNS). + = stimulation and - = inhibition.

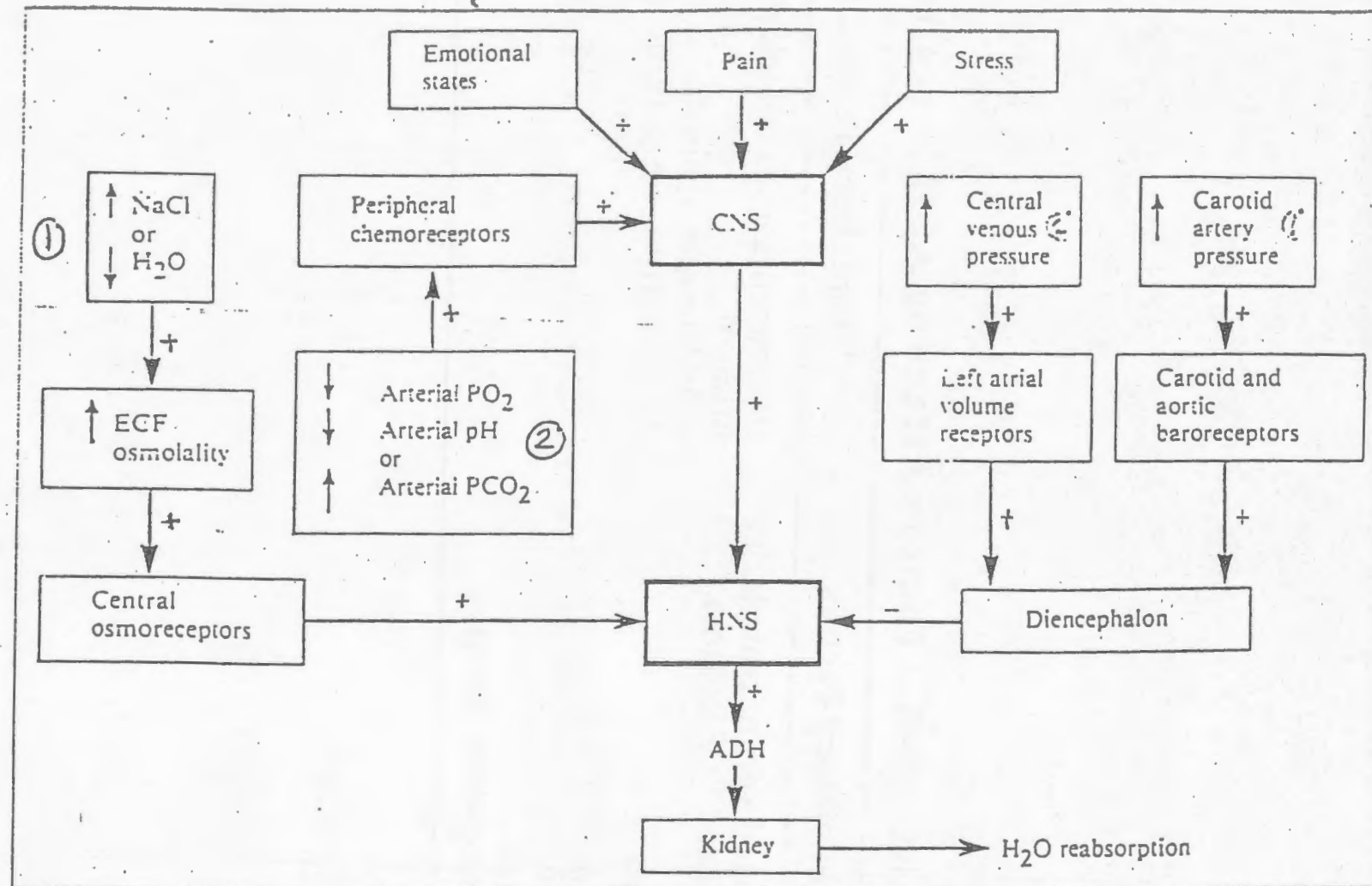


TABLE 9-6. Factors Affecting ADH Secretion

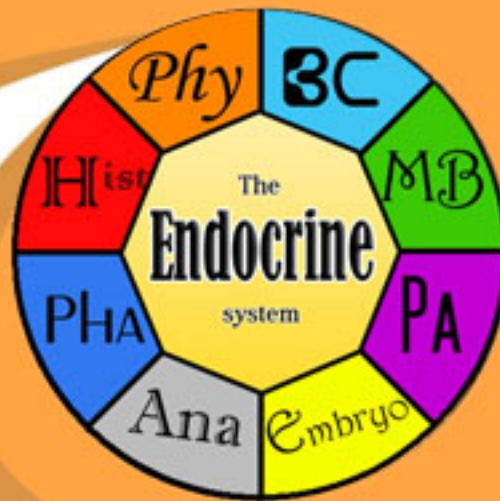
Stimulatory Factors	Inhibitory Factors
Increased serum osmolarity	Decreased serum osmolarity
Decreased ECF volume	Ethanol
Pain	α -Adrenergic agonists
Nausea	Atrial natriuretic peptide (ANP)
Hypoglycemia	
Nicotine	
Opiates	
Antineoplastic drugs	



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Faculty of Medicine



Medical Committee
The University of Jordan



Physiology

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27th March. 2014		

Title: ORGAN SYSTEMS AND BASIC CONCEPTS

Professor: Dr. Saleem Al-Khraisha -1

Written by:
Hala Al-Makahleh

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Endocrine system

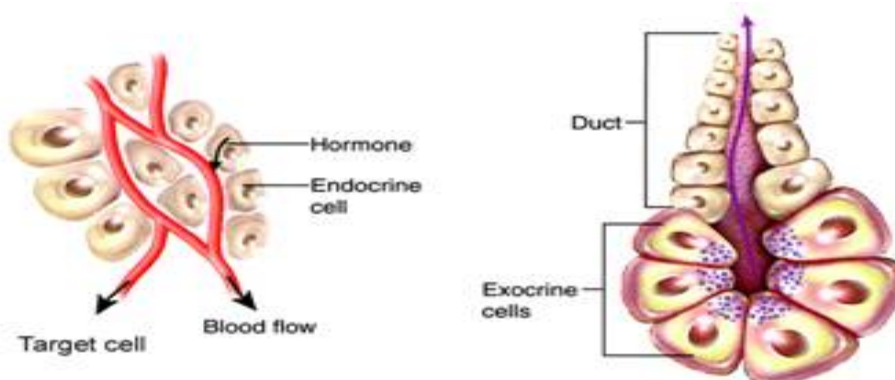
These are the systems of the body:

- ❖ The nervous system, skeletal, cardiovascular, respiratory, digestive, urinary, endocrine, reproductive, lymphatic, and immune. These systems form the body of the humans and mammals.
 - From these systems just two systems control the human body: **nervous system** and **endocrine system**, one for immediate action and the second for delayed action.
 - Endocrine system for immediate action and sometimes for delayed action like the release of adrenaline from the adrenal medulla, Nervous system for immediate action.
- ❖ Now we compare these two systems:

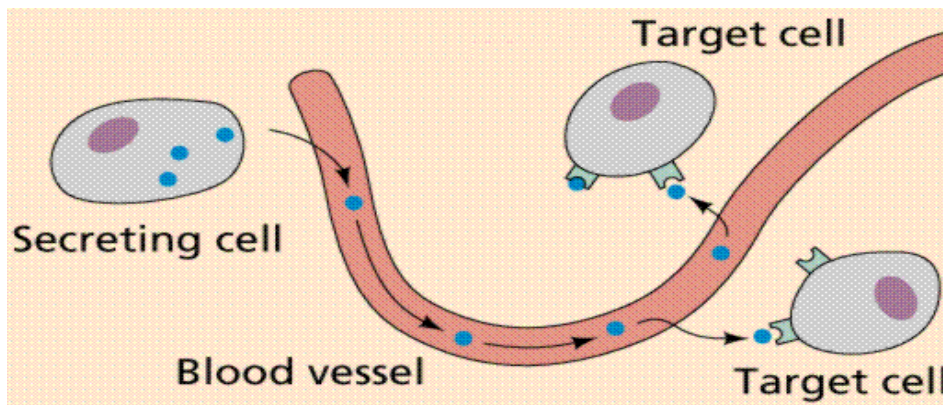
Characteristic	Nervous System	Endocrine system
Mechanism of control	Neurotransmitters release in response to nerve impulse, from neuron to neuron, from neuron to muscle cell, from neuron to gland cells.	Hormones are delivered usually directly in the blood to tissues.
Cells affected	Nerves, muscles, gland cells.	Almost all the cells of the body.
Types of actions	Neuron to neuron: action potential in the second nerve. Neuron to muscle: muscle contraction. Neuron to glandular cells: secretions of enzymes or hormones.	Changing in metabolism either anabolism or catabolism.
Time to onset of action	Usually immediate	Usually delayed sometimes immediate
Duration of action	Generally brief	Generally longer

The types of hormones or glands :

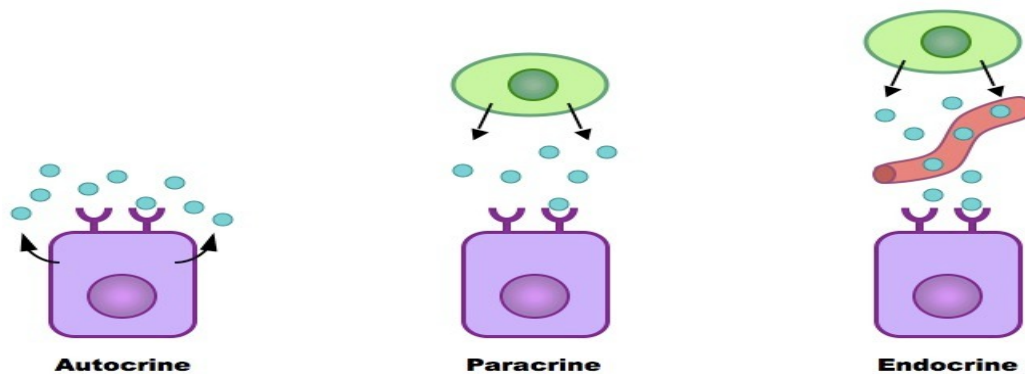
- ❖ **Exocrine glands** their secretions are released into a duct open either inside the body into a lumen such as the intestine or outside the body such as sweat glands.
- ❖ **Endocrine glands**, there are two types of endocrine glands (ductless glands) classic endocrine glands and other endocrine glands:



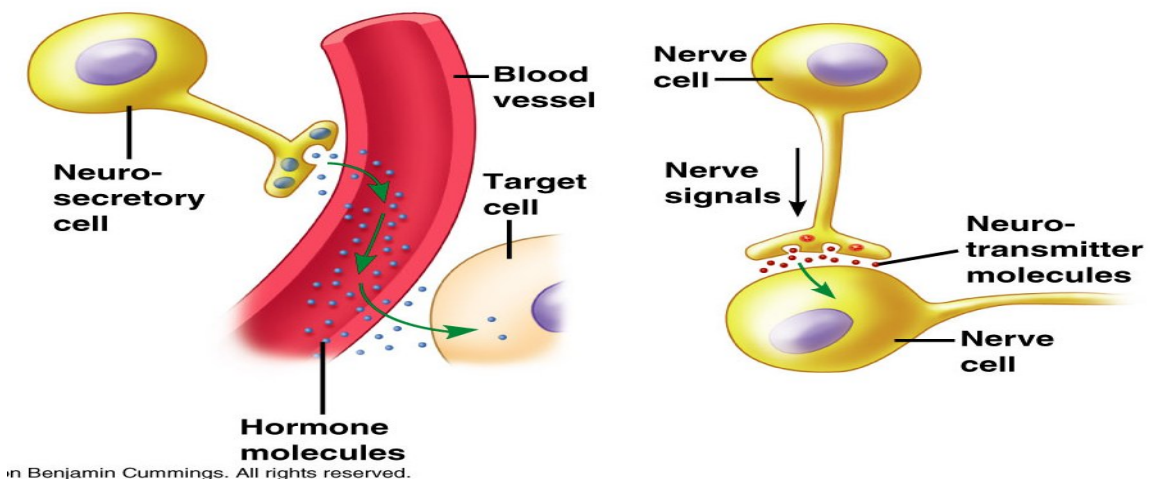
- **Classic endocrine glands** are group of cells synthesis and secrete chemical substances called hormones, directly into the blood, and through the blood the hormones reach their target cell, these are classic endocrine glands, and the hormones also are classic hormones.



- Other endocrine glands do not release their hormone directly into the blood, but these are minor glands:
 - **Autocrine glands:** hormones synthesized in endocrine cells and sometimes released into the interstitial spaces, bind to specific receptor on the cell of origin.
 - **Paracrine glands:** hormones synthesized in endocrine cells and sometimes released into the interstitial spaces, bind to specific receptor of nearby cells affecting their function.



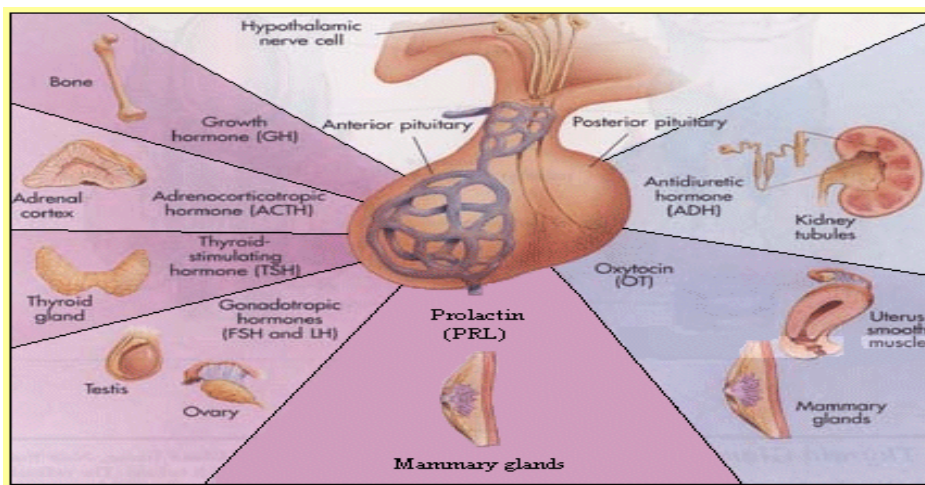
- ✓ **Neuroendocrine:** two subtypes; the first subtype is hormone produce by neurons and release directly into the blood, example: posterior pituitary. The second subtype is hormone produce by neurons and release into the cleft affecting the post synaptic neurons, so these hormones are neurohormones either release into the bold or into the synaptic cleft, example: Adrenalin from the sympathetic nervous system.



- ✓ **Pheromones:** are volatile hormones released into the environment act on olfactory cells of another individual, so they are substance produced by an animal usually that act at distance to produce hormonal, behavioral, or other physiologic changes in another animal of the same species :
 - In animals the deers produce the musk it affect the other deers and it is produced by the males not the females, also the amber produced by whales.
 - And these pheromones might be present in human beings, people getting attracted to each other by these pheromones.

❖ Some important points about the endocrine system :

- A single endocrine gland may produce many hormones such as anterior pituitary, pancreas.



- Some hormones have multiple actions in their target tissues called tropic hormones or effects, this phenomenon occur when single hormone regulates several functions in the target tissue, example: in skeletal muscles insulin stimulates glucose uptake, glycolysis, glycogenesis, inhibit glycogenolysis, stimulates amino acids uptake, stimulates protein synthesis and inhibit protein degradation. The same for insulin in the liver or adipose tissue.
- Single hormone may be secreted by more than one endocrine gland such as somatostatin secreted by the hypothalamus and the pancreas.
- Some hormones are known to have several effect in several different target cells, example the testosterone, the male sex steroid hormone, for normal sperm formulation in the testes, stimulates growth of accessory sex organs or glands such the prostate and the seminal vesicle and promotes the developmental of several secondary sex characteristics such as beard growth and deepening of the voice.
- There is also multiplicity of regulation in the endocrine system the input of information from several sources allows highly integrated response to many stimuli which is of ultimate benefit to the whole animal, for example: several different hormones insulin, glucagon, epinephrine, thyroid hormones, adrenal glucocorticoids may regulate liver glycogen metabolism, they produce simply the normal plasma glucose level all these hormones together.

- Single target cell may be influenced by more than one hormone, some cells contain many types of receptors responding in different ways to different hormones, to illustrate: insulin promotes the conversion of glucose into glycogen within the liver cells by stimulating one particular hepatic enzyme, whereas another hormone which is "Glucagon" enhances the degradation of liver glycogen, so the insulin increases the glucose level in the blood and the glucagon decreases the glucose level in the blood, because the same cells in the liver have different receptors, some receptors for insulin and some others for the glucagon.
- The same chemical messenger may be either a hormone or neurotransmitter, such as somatostatin either neurotransmitter produced by the hypothalamus or hormone produced by the pancreas.
- Some glands in the body produce just hormones, but there are other organs in the body that produce hormones in addition to other functions such as intestine (produce hormones as well as enzymes or other secretions), ovaries (produce hormones as well as producing ova), testes (produce hormones as well as sperms).
 - In this figure you see the only endocrine glands, also you see the mixed organs; they have nonendocrine function in addition to secretion of hormones such as stomach, pancreas, ovaries, lungs, heart, kidney, intestine etc...(refer to slides)

❖ The general functions of the hormones:

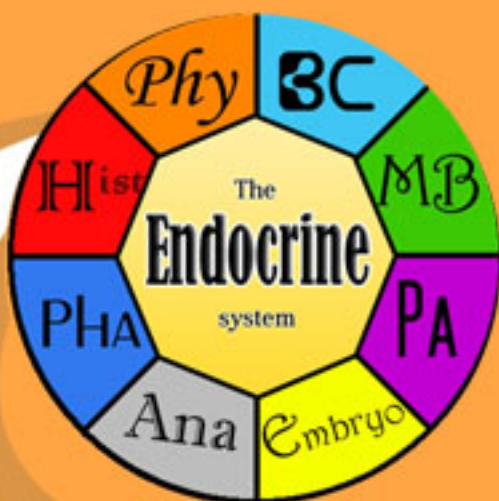
- **Metabolism:** hormones regulate the metabolism either anabolism or catabolism.
- **Reproduction:** there is no reproduction without hormones, no sperms without testosterone and other androgens or estrogen (because the estrogen also has a role in the production of the sperms), no ova without estrogen and progesterone.
- **Digestion:** digestive system does not function without hormones; it needs hormones to function properly.
- **Blood circulation:** cardiac output, blood pressure, vasoconstriction, vasodilatation and control the blood volume and consequently the body fluid volume, all these are controlled by hormones, and any wrong especially in some specific hormones all previously mentioned things are disturbed.
- **Transport of substances to tissues:** many substances are transported by hormones or increased or decreased its concentration in the blood.
- **Defense against pathogens:** immune system responses are regulated by hormones, such as inflammation, antibody production and fever.
- **Growth:** it does not occur properly without growth hormones, deficiency in GH leads to dwarfism as well as cretinism.
- **Stress response:** regulate the body's response to stresses.
- **Behavior:** hormones affect the behavior; the behavior of the females is different from the behavior of the males because of hormones, females shy and cannot fight because of the estrogen, males fight because of testosterone.



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Physiology

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<input type="checkbox"/>	Sheet	
2nd Apr. 2014		

Title: GROWTH HORMONES

Professor: Dr. Saleem Al-Khraisha -4

Written by:

Jenan Al-hamed

Price: 10

6/4/2014

D&GN: WBK



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-the same result will be observed if the rat was injected ONLY with insulin "there'll be a little increase in the growth".

-But if the rat was injected with both, GH & insulin, there'll be faster increase in the growth. "remember that these two hormones function synergistically".

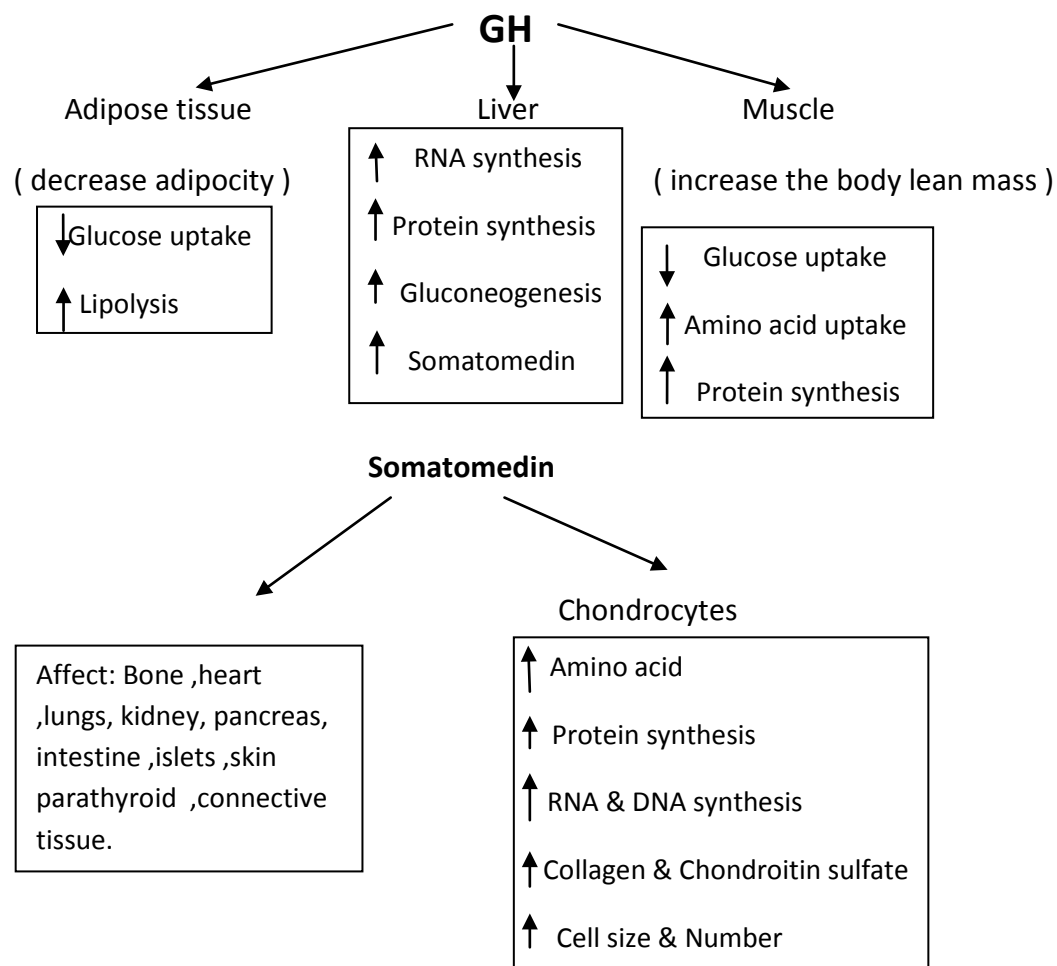
*GH affects the cells of the body in two ways:

1)Directly 2)Indirectly

-Directly by affecting the adipose tissue ,liver & muscle cells.

-When the GH affects the liver ,it'll produce proteins ,which are hormones called ((somatomedin)) OR ((Insulin-like growth factors)).

-Somatomedin are many hormones "about 6 hormones" that have a similarity in their structure ,also in their function ,but they vary in their potencies.



-Somatomedin are the indirect effects produced by GH.

*So, the GH exerts its effect either directly, which is the Main way for the GH, or indirectly.

*From the functions of the GH, the metabolic ones are important because they're essential for the human beings minute by minute and hour by hour.

***Metabolic Effects of GH :-**

1) Increased rate of protein synthesis (increase rates of GH is probably resulted by increased rate of protein synthesis)

2) Increased mobilization of fatty acids or energy.

3) decreased rate of glucose utilization.

-GH enhances the body protein, uses up "utilizes" the free fatty acids for energy & conserves carbohydrate.

(It spares the glucose to be available at any minute for energy, because glucose is for Fast energy)

***Hypersecretion of GH :-**

(There's an excess "NOT normal" in the secretion of GH)

A)Diabetogenic effect of GH

-GH increases blood glucose concentration.

-It may affect the Beta-cells of pancreas directly , causing over exhaustion of beta cells

-Finally, the result is a diabetes mellitus.

*Direct & indirect effects by production of insulin as well as affecting Beta-cells.

B)Ketogenic effect of GH

***Effects of GH in enhancing fat utilization, for energy:-**

1) Increases the release of fatty acids from the adipose tissue.

2) Fatty acids concentration increases in body fluids.

3) It enhances the conversion of fatty acids into Acetyl-CoA, with the subsequent utilization for energy.

4) In this case spare the protein.

5) Under the effect of GH ,the mobilization of fat requires minutes to hours, where as protein synthesis can be in minutes, because protein synthesis is performed by many hormones NOT only GH.

6) Under the excessive of GH ,great amount of fat mobilized, therefore a lot of acetoacetic acids are formed by the liver, causing ***Ketogenic effect***.

***Diabetogenic effects of other anterior pituitary hormones:-**

1)TSH 2)Prolactin 3)ACTH

*The most important hormones ,which are functioning together, are GH & Insulin in:-

1)Protein intake

2)Carbohydrate intake

3)Fasting

-In protein intake--->Both GH & Insulin increase including somatomedin

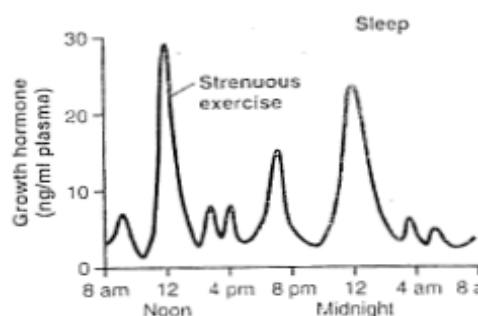
-In carbohydrates intake---> JUST insulin increases ,because it leads to the entering of glucose into the cells, but GH is NOT needed in this condition.

-In fasting---> JUST GH increases ,here we don't need insulin, we need glucose from non-carbohydrate sources.

*The secretion of the GH shows a diurnal rhythm as well as pulses or oscillation rhythms & developmental rhythm.

*The level of GH during the 24 hrs.. the highest at 12 noon and at 12 midnight

the probable explanation of high GH at midnight is the escape of the cells which secrete GH from their control by nerves ,so body becomes out of control of the nerves ,so death is mostly at 3-5 a.m



***Factors that stimulate or inhibit secretion of GH :-**

-The most important in **stimulating** GH is the metabolic, especially the Glucose.

-Also, the Ghrelin, which is a hormone produced by the stomach as well as in the intestines .

"They're saying now that it might be produced by the pancreas"

-Ghrelin can stimulate the appetite.

Stimulate Growth Hormone Secretion

Decreased blood glucose
Decreased blood free fatty acids
Increased blood amino acids
(arginine)
Starvation or fasting, protein deficiency
Trauma, stress, excitement
Exercise
Testosterone, estrogen
Deep sleep (stages II and IV)
Growth hormone–releasing hormone
Ghrelin

-The most important factors that **inhibit** GH secretion are: Obesity, Aging & somatomedin. Others are increased blood glucose and free fatty acids, GH inhibitory hormone (somatostatin) and Somatomedins

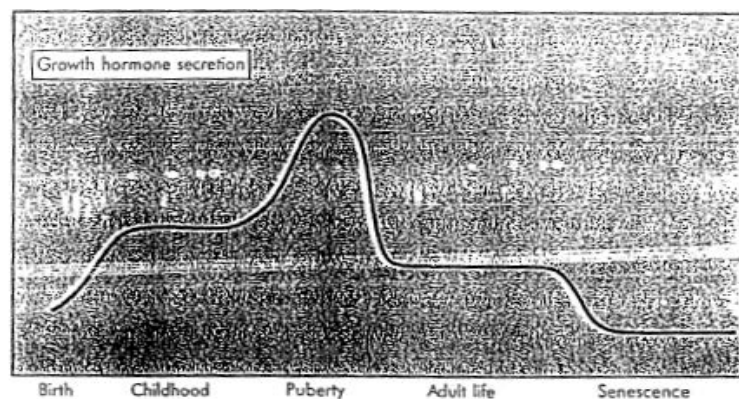
-Stretch receptors in the stomach, as well as hormones along with these receptors, inhibit food intake.

-Peptide YY(PYY), cholecystokinin(CCK)& insulin are gastrointestinal hormones, that are released by the ingestion of food & suppress further food intake

-Obese individuals have large stomach, stretch receptors are away from the food, so they take a lot of food in order to touch the receptors.

Therefore, they've to accommodate gradually to decrease their food, so the stretch receptors to become closer to the food.

*The level of GH during the life:-



■ Fig. 48-19 Lifetime pattern of growth hormone (GH) secretion. GH levels are higher in children than adults with a peak period during puberty. GH secretion declines with aging.

-From birth till death."Developmental rhythm".

-There's NO significant difference between adult & childhood."Little bit higher in the childhood".

*ALL types of stresses can lead to increase the secretion of GH.

***The pituitary gland deficiency:**

The **hyposecretion** of the pituitary gland is NOT a pathologic, it's a physiologic case.

The results of deficiency of pituitary hormones(both post. & ant. pituitary hormones):-

A)Panhypopituitarism

*"pan = all " ,the deficiency of ALL pituitary hormones

*Oxytocin is NOT mentioned here, meaning that it's NOT so important. "its deficiency is NOT very serious".

1)ADH deficiency: water is NOT reabsorbed probably back into blood, it's excreted ,so there'll be a lot of urination (about 20 liter per a day).
If the patient is not treated ,then he'll die. This disease is called ((Diabetes insipidus)).

2)Gonadotropin deficiency: (**LH & FSH**)

In male: Decreased lipido (There's NO testosterone), asperemia (NO sperms),loss of some facial and body hair.

*note : LH affects leydig cells leading to testosterone synthesis

In female: Also decreased lipido_& amenorrhea(NO menstrual cycle).

3)TSH deficiency: Hypothyroidism.

4)ACTH deficiency: "adrenal cortex hormones are affected"

5)MSH deficiency: pallor color.

6)GH deficiency: causes dwarfism but mentally is normal.

B)Severe anterior pituitary deficiency

*It's similar to Panhypopituitarism except those of the post. pituitary hormones are **normal**.

C)Moderate anterior pituitary deficiency

*Gonadotropins& TSH are deficient, ACTH & MSH are partially deficient, GH is normal.

D)Mild anterior pituitary deficiency

*JUST Gonadotropins are deficient ,the others are normal.

we can notice that in ALL conditions "A-->D" Gonadotropins are deficient

-Hypersecretion of GH:

a) Giantism or qigantism

*If the over-secretion occurs before being adult(during the childhood),almost all the organs will be affected & become larger than normal.

*These individuals will:

-Be 8-9 feet height.

-The giants have hyperglycemia,10% develop diabetes mellitus.

-If the giants remain without treatment ,they'll develop panhypopituitarism.

*All parts of the body develop in appropriate proportion.

-Also the organs will be enlarged .

b) Acromegaly

*If the over-secretion occurs after being adult, after the fusion of the long bones ,the person cannot grow taller (bones cannot grow) ,but the soft tissues can continue growing and the bones can grow in thickness.

***These individuals will :**

-Suffer from enlargement of the small bones of hands ,feet, cranium ,nose ,forehead ,supraorbital ridges , the lower jaw bone and portions of the vertebrae.

-Many soft tissues or organs like : liver ,tongue ,kidneys are enlarged. "also the heart but it's a little bit enlargement".

*There's NO appropriate proportion in the development.

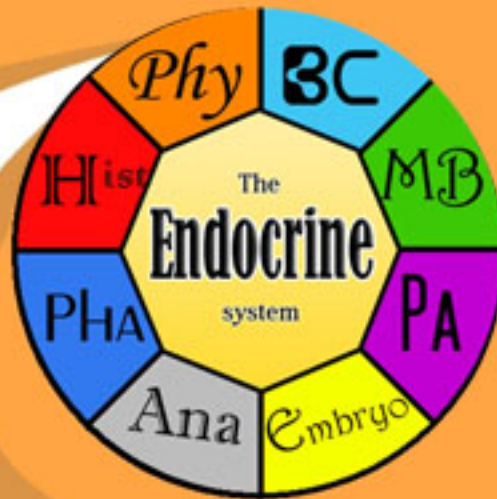
Done by: Jenan Al-Hamed



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Physiology

<input type="checkbox"/>	Slides	#	5
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3-4- 2014			

Title: ADRENAL GLANDS

Professor: Dr. Saleem Al-Khraisha -5

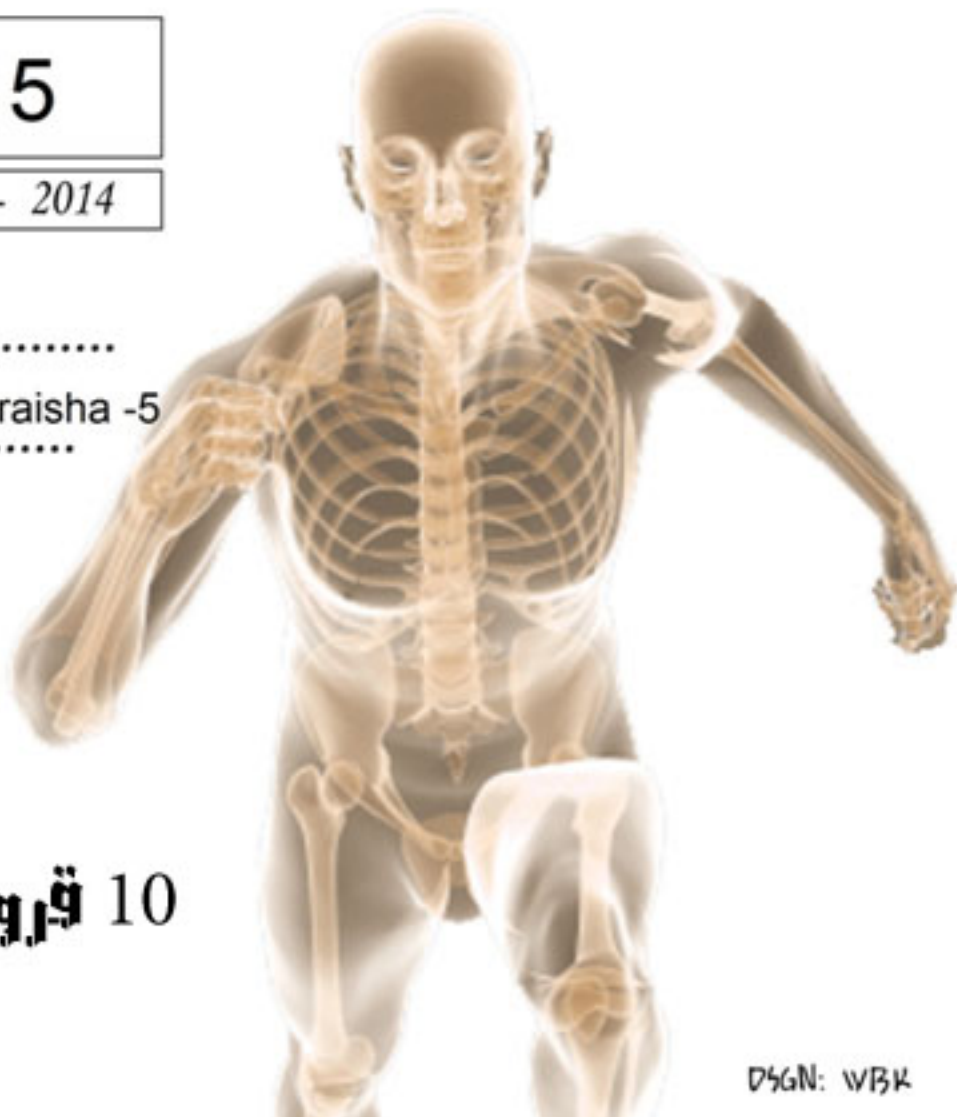
Written by:

Ahmad Alwan

Price:..... 10

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6/4/2014



D&GN: WBYK

THE ADRENAL (SUPRARENAL) GLANDS

They are two glands, present above the kidneys. One adrenal gland is sufficient for human beings/mammals (example: we also have two kidneys but one is sufficient).

The Adrenal glands receive their blood supply from the aorta directly and hence they are essential for life, if we remove these glands from the embryo it will not survive. Their total weight is 6-10 g.

Each Adrenal gland is made up of two parts -two distinct organs- which differ in their histology, embryology, and functions (physiology):

- 1- **Adrenal Cortex - 80%**
- 2- **Adrenal Medulla - 20%**

The adrenal cortex is essential for life (since it controls Na, K and water metabolism) and not the adrenal medulla (since its hormones e.g. adrenaline can be produced by other organs like the sympathetic nervous system.)

In physiology of the endocrine system we will only discuss the adrenal cortex (we'll take the adrenal medulla later when we take the autonomic nervous system.)

📌 Adrenal cortex secretes 3 main hormones:

- 1- *Glucocorticoids* (Cortisol - the main **target** for ACTH)
- 2- *Mineralocorticoids* (Aldosterone) - ACTH has a minor effect on them
- 3- *Androgens* (Sex hormones) - ACTH has a minor effect on them

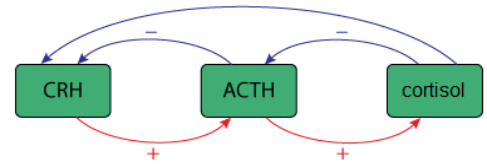
📌 Control of adrenal cortex secretion:

The Anterior pituitary gland secretes ACTH which regulates the **growth** of adrenal cortex cells in addition to the **synthesis** and **secretion** of its hormones. Fetal ACTH synthesis and secretion by the anterior pituitary gland begins just before the development of the adrenal cortex. The adrenal cortex is essential even for the development of the fetus. The extra-adrenal actions of ACTH include lipolysis and MSH-like actions.

Regulation of ACTH is among the most complicated of all the pituitary hormones. The following regulate the secretion/synthesis of ACTH (Adrenocorticotrophic hormone):

- 1- CRH (corticotropin-releasing hormone) – most important, it is a hypothalamic hormone.
- 2- ADH : exhibits the same action as CRH
- 3- Neurotransmitters
- 4- Anxiety
- 5- Depression
- 6- All kinds of stress (infection, trauma, anesthesia, surgery...)

ACTH secretion responds most strikingly to stressful stimuli: a response that is critical to survival.



- Extra note:
- Cortisol provides negative feedback to the hypothalamus to inhibit CRH secretion and to the anterior pituitary gland to inhibit ACTH directly.
- ACTH provides negative feedback to the hypothalamus to inhibit CRH secretion.

❓ The **functions** of the adrenal cortex - essential for life; include:

- 1- Controls Na^+ , K^+ , and H_2O metabolism.
- 2- Controls carbohydrate, fat and protein metabolism and mobilization for energy.
- 3- Participates in the response to stresses of various kinds.

❓ The adrenal cortex is divided into **three zones of cells**:

- **Zona Glomerulosa - 12%**
 - Produces: Mineralocorticoids – represented by *Aldosterone*. Those control the metabolism of minerals and water.
- **Zona Fasciculata - 65%**
 - Produces: Glucocorticoids – represented by *Cortisol* as well as small amounts of *Androgens*. Function: glucose metabolism.
- **Zona Reticularis - 23%**
 - Produces: Androgens as well as small amounts of *Cortisol*. This zone doesn't differentiate fully until between 6 and 8 of years of age.

In adults, zona glomerulosa cells continuously migrate down to reticularis through fasciculata, they change their morphology, function and secretory pattern as they go.

❓ Now we will clarify the meaning of **mineralocorticoid and glucocorticoid activity** and the role of *Aldosterone and Cortisol* in each one:

♣ **Mineralocorticoid activity**: measured in terms of the ability of the hormone to reduce the ratio of excretion of sodium to the ratio of excretion of potassium in urine. (In other words: the ability to retain Na^+ and excrete K^+ .)

♣ **Glucocorticoid activity**: measured as the ability of the hormone to increase glycogen concentration in the liver and increase glucose concentration in blood.

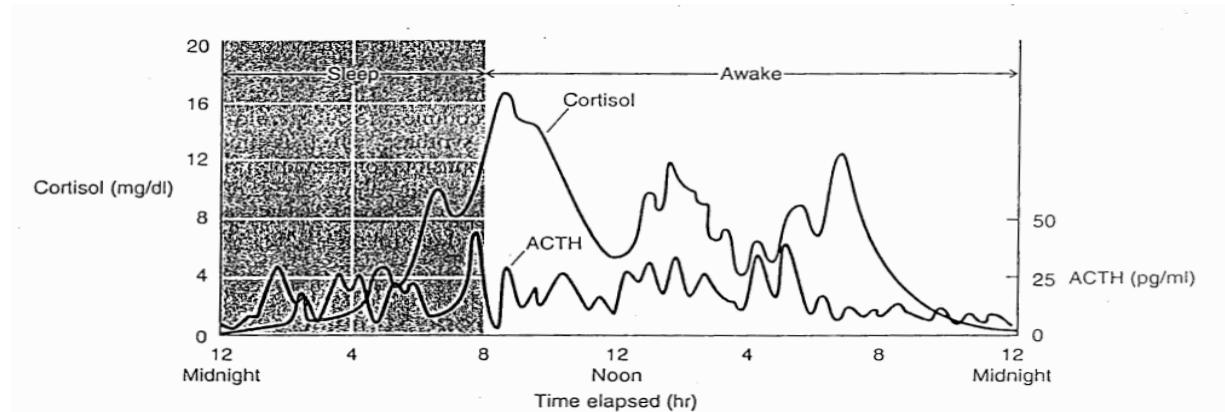
♣ **In terms of potency**:

- 1- **Aldosterone** accounts for 90% of all mineralocorticoid activity while **Cortisol** has very slight mineralocorticoid activity.
- 2- **Cortisol** accounts for 95% of all glucocorticoid activity while **Aldosterone** has very slight glucocorticoid activity.

♣ **In terms of actual participation:** Cortisol's mineralocorticoid contribution is greater than aldosterone's glucocorticoid contribution. This is due to the secretion rate: the adrenal cortex produces more cortisol than aldosterone and this compensates for the weakness in its potency toward mineralocorticoid activity.

	potency in mineralocorticoid activity	potency in glucocorticoid activity	rate of secretion	real participation in mineralocorticoid activity	real participation in glucocorticoid activity
aldosterone	very potent	weak	less	very potent	weak
Cortisol	Weak	very potent	more	potent	very potent

❓ The change in ACTH concentration is parallel to change in Cortisol concentration: as ACTH increases Cortisol increases as well. ACTH release is greater in the early morning hours.



❓ Remember that steroid hormones are divided into: sex hormones and adrenal cortex hormones. Both are synthesized from cholesterol. The **production of Steroid hormones** involves many reactions and many steps and each reaction requires its own enzyme:

♣ As we know, the production of *cortisol* is mainly in the *fasciculata*. When cortisol production decreases or is blocked due to many factors (like enzyme deficiency), the concentration of *Corticosterone* hormone will **increase**. (The doctor didn't say the reasons but I think it is due to the absence of the main negative feedback inhibitor which is cortisol as we said previously.) In rats there is only corticosterone and no cortisol.

♣ Adrenal cortex hormones are released immediately upon synthesis and they are not stored. When there is an immediate need for new hormones new synthesis is required.

❓ 90% of cortisol **binds** to CBG "corticosteroid -binding protein" and 6% binds to albumin. The active form which is the free form of cortisol is 4%.

❓ **The main functions of Cortisol:** it functions on almost all the organs. Those are the main ones.

- 1- Production of glucose from protein by gluconeogenesis.
- 2- Fat mobilization.
- 3- Supports the vascular response.
- 4- Modulates CNS functions.

Also:

- Acts on fat cells: increases lipolysis.
- Skeletal muscles: Increases amino acid mobilization.
- Immunosuppressive.
- Stress response – Increased vascular response
- Affects the liver:

♣ When there is a decrease in glycogen in the liver and there is a deficiency of cortisol → the human will die of hypoglycemia (low blood glucose). Remember that cortisol is **responsible** for the synthesis of glucose from protein (**gluconeogenesis**). Cortisol is essential for life especially for fasting human beings and animals.

♣ Cortisol **doesn't** promote **glycogenolysis**. It facilitates the action of glucagon. This is called permissive hormone interaction.

♣ Cortisol can bind very well to aldosterone receptors, but there is an enzyme called **hydroxysteroid dehydrogenase** which continuously inactivates cortisol and hence the actions of aldosterone and cortisol are not similar. In the absence of this enzyme their actions become similar the human being can't survive because everything in the body will be degenerated.

❓ **The Adrenal glands are unique during the fetal life** especially after four months of pregnancy. They are unique in their **size** and **function**:

♣ **Size:** The size of adrenal glands in the fetus after 4 months of pregnancy is larger than the size of kidneys

♣ **Function:** Both parts -the adrenal cortex and medulla- function properly during the fetal life.

Cortisol particularly has very important functions during the fetal life:

- 1- Production of surfactant from type 2 cells of the alveoli of the lung, a lack of surfactant which leads to the respiratory distress syndrome in newborns. If the newborn doesn't breathe properly we give him cortisol and after a few minutes he will start breathing.
- It is called the magic drug: Cortisol diffuses into every cell in body with a nucleus. Cortisol treats and cures many diseases (Heart, skin, lung...etc). The strange thing is that sometimes it could cure one patient completely but have no effect on another, no one knows why, although some believe it could be due to a lack of receptor, a blood disease, or a genetic condition.

- 2- Development of hypothalamic function and development of the thyroid-pituitary axis.
- 3- The sequential changes of the placental structure and in the ionic composition of amniotic and allantoic fluids during development.
- 4- They are most important in the initiation of the endocrine changes of the fetus and mother which are responsible for parturition.
- 5- The development of hepatic enzymes, including those involved in gluconeogenesis.
- 6- Induction of thymic involution.

❓ Natural and synthetic Glucocorticoids:

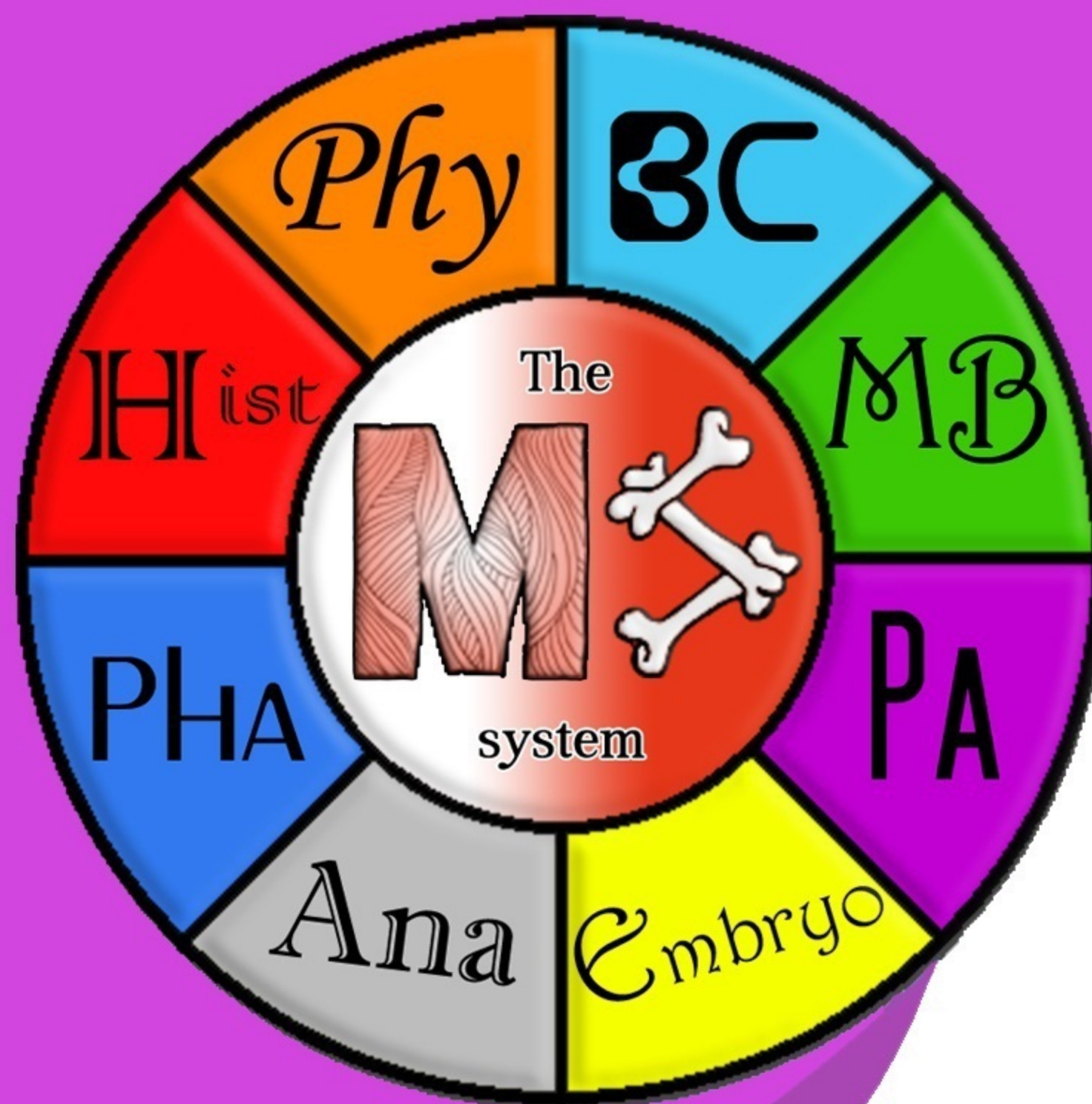
- Natural:
 - Cortisol
 - Corticosterone
- Synthetic: more potent
 - Cortisone
 - Prednisone
 - Methylprednisone
 - Dexamethasone



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PATHOLOGY

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<input type="checkbox"/>	SHEET	
3rd Apr.2014		

TITLE: BONE TUMORS

PROFESSOR: _____

WRITTEN BY: _____

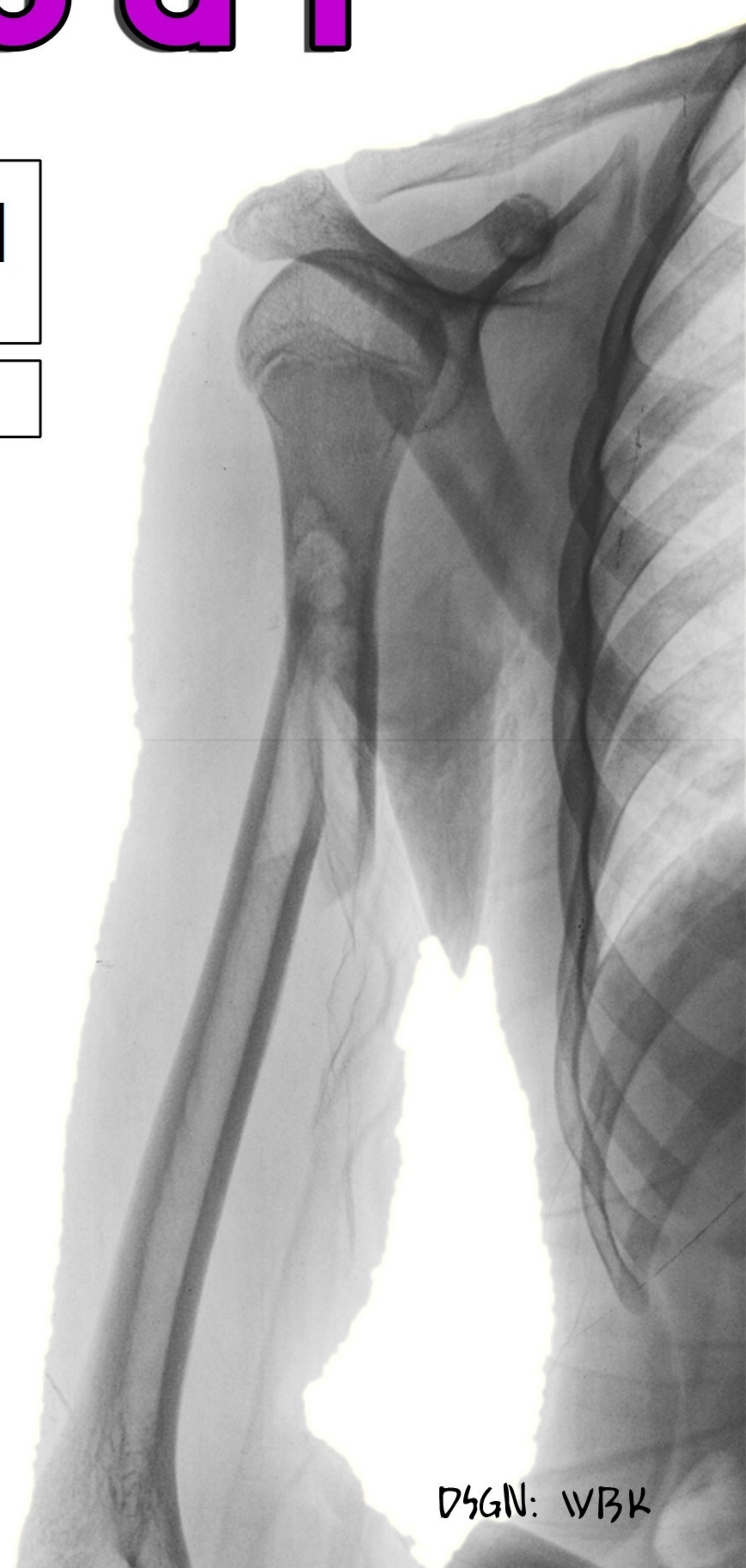
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MSK system- 2nd yr medical students

Lab #1

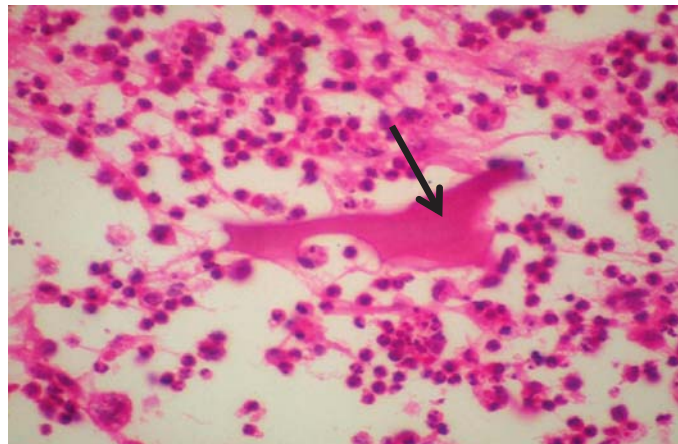
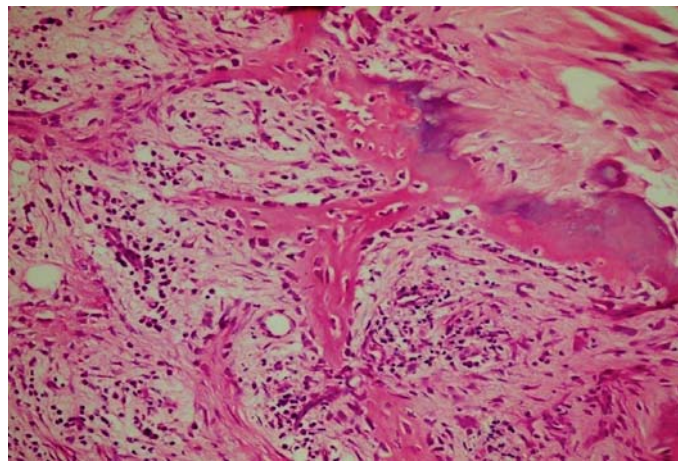
Slide BB 179 : Osteomyelitis

•Describe the microscopic findings in this picture.

•What is the most common offending microorganism ?

•What does the black arrow represent?

•Name 3 complications of chronic osteomyelitis.

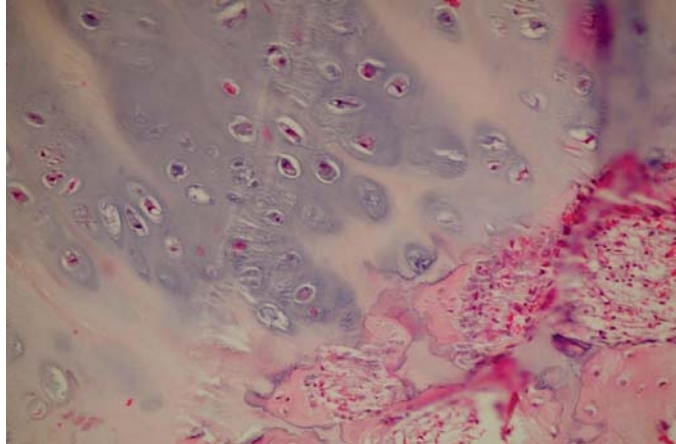
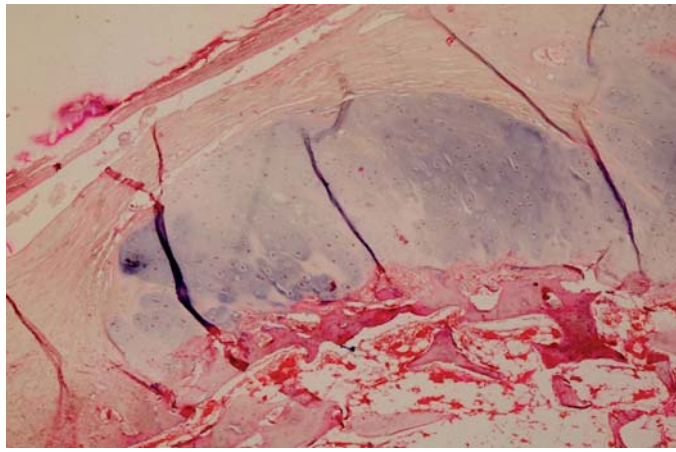


Slide L131: Osteochondroma

- Describe the histologic components of this lesion. Which one is truly neoplastic?

- Is it a malignant tumor?

- Name a genetic abnormality associated with this lesion?



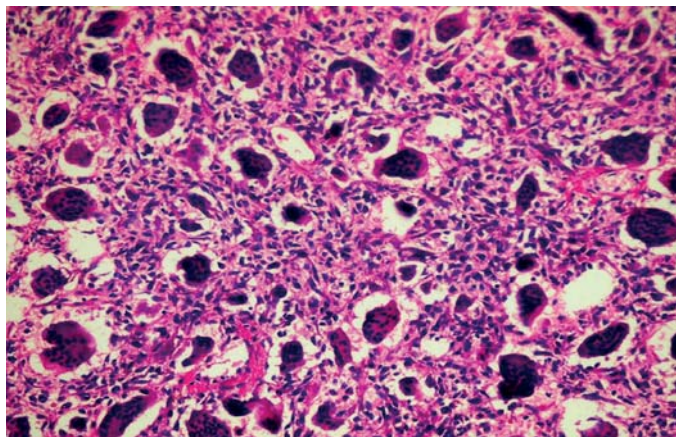
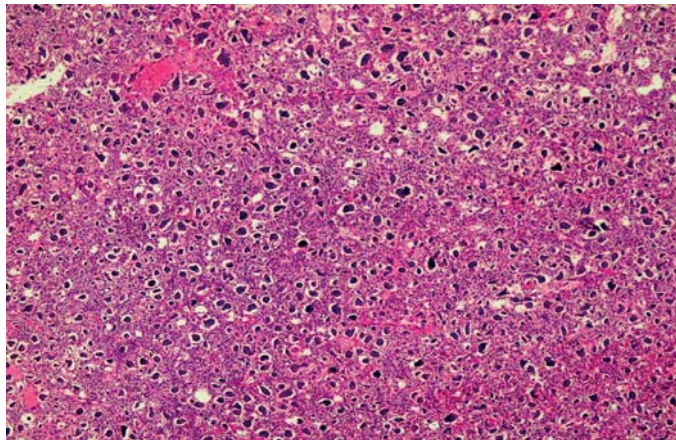
Slide L208: Giant cell tumor

- a common benign but locally aggressive bone tumor, belongs to the “Miscellaneous Bone Tumors “

- arise in the epiphysis and involve the metaphysis of long bones around the knee (distal femur & proximal tibia)

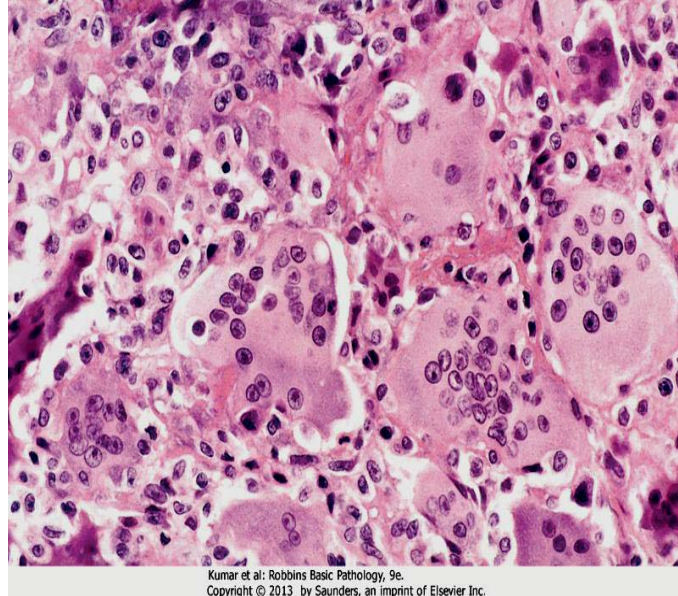
- usually arise in 20s to 40s.

- Prominent non-neoplastic multinucleate osteoclast-type giant cells.



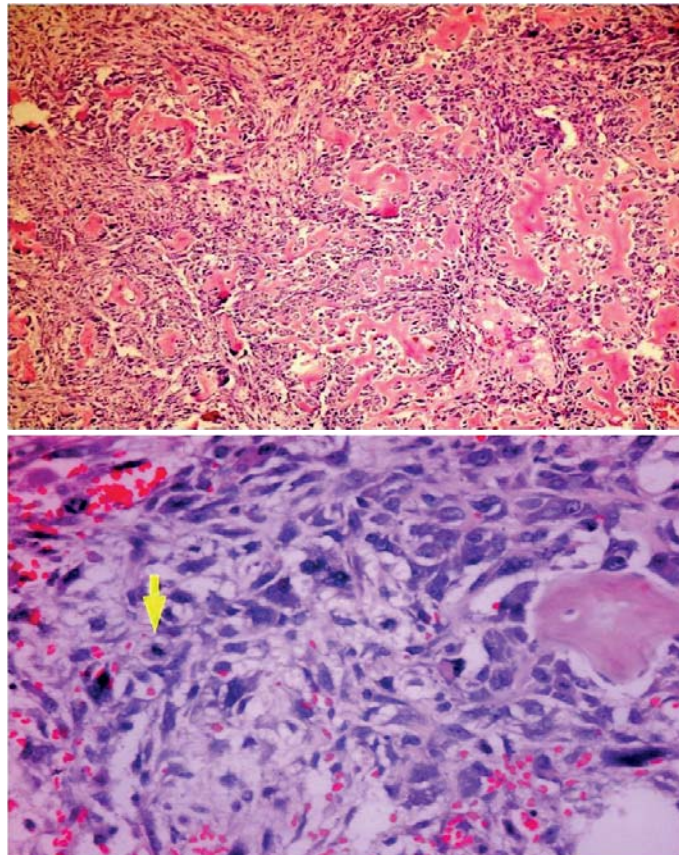
Slide L208: Giant cell tumor

- Despite the name, molecular analyses have shown that it is the mononuclear cells in the tumor that are neoplastic.
- Mononuclear cells express RANK ligand → stimulate the development of surrounding non-neoplastic osteoclast-like cells.
- Although considered benign, (1/2 of cases) recur after surgery



Slide L 213: Osteosarcoma

- This is a microscopic picture of a femur tumor in a 21 year old male. What is your diagnosis?
- What is the diagnostic histopathologic finding?
- Describe the anaplastic features you see in the cells.
- Name 2 genetic syndromes associated with this lesion.



Please make sure to study the following jars from the pathology lab:

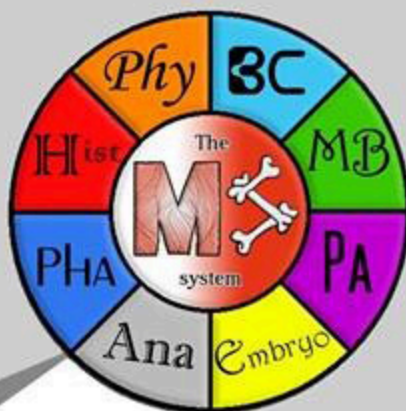
- 8/14➔ chondrosarcoma
- 2/14➔ osteosarcoma (Codman's triangle)
- 5/15➔ sequestra (osteomyelitis)



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Anatomy

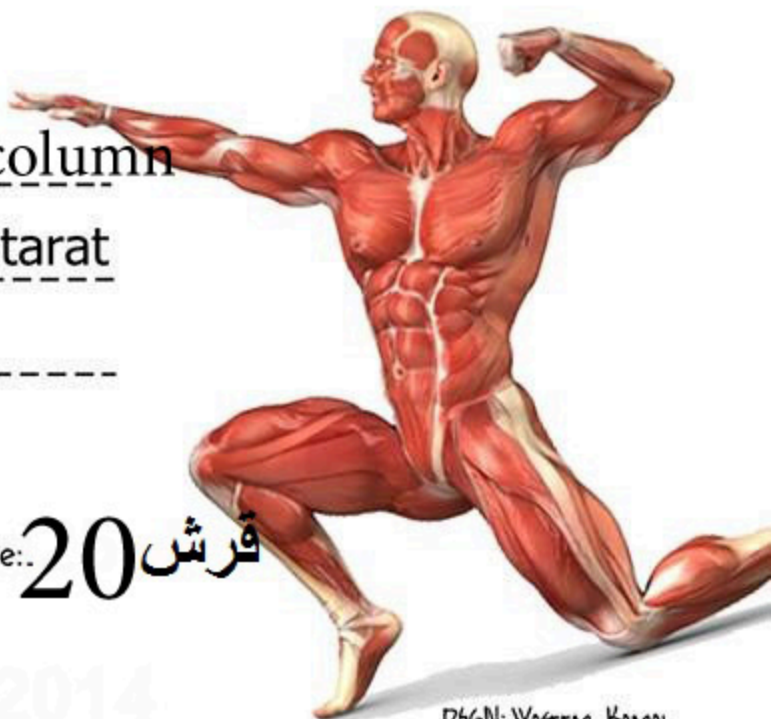
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Title: mssvertebral column

Professor: Dr.Amjad Shatarat

Written by: _____

Price: 20 قرش



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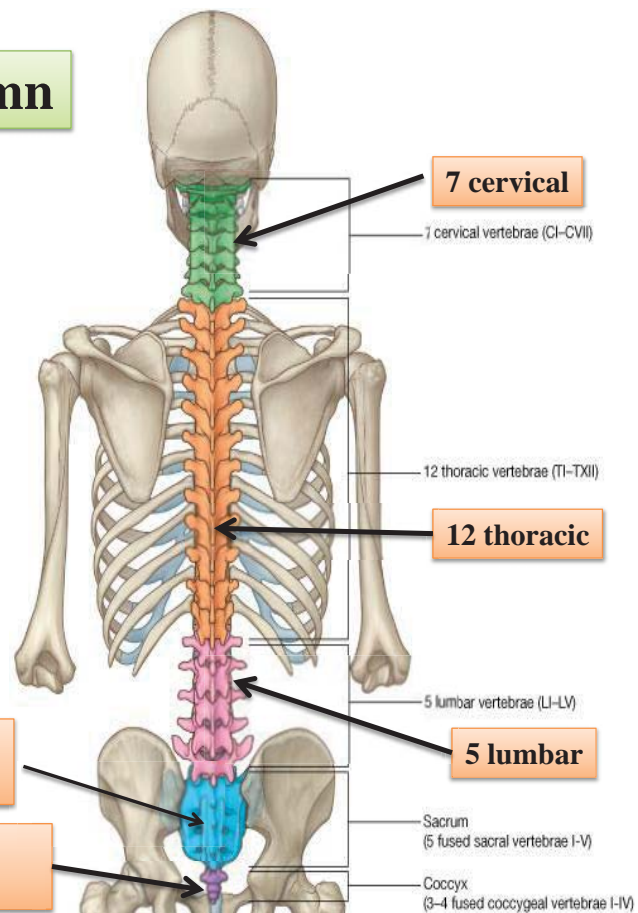
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19/3/2014

D4GN: Waseem Kanaal

The Vertebral Column

Is composed of 33 vertebrae



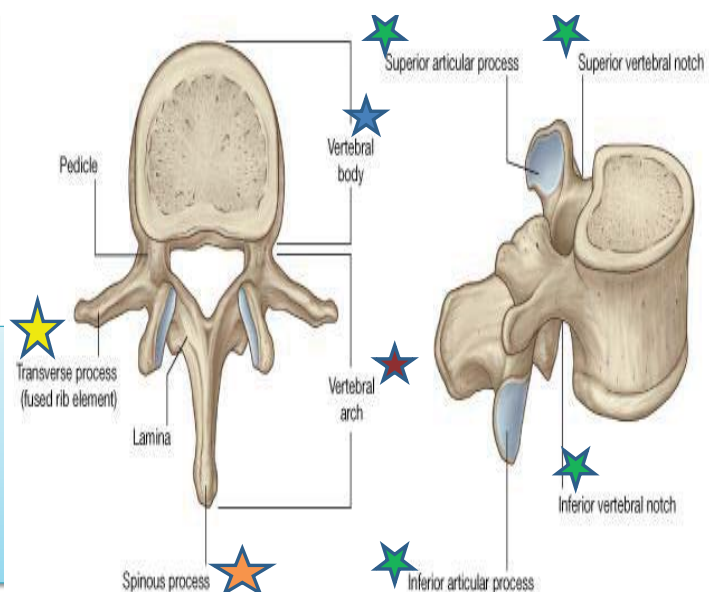
A typical vertebra consists of:

- 1-a rounded body anteriorly
- 2-a vertebral arch posteriorly.

They enclose a space called **The vertebral foramen** through which run the spinal cord and its coverings

The vertebral arch gives rise to seven processes:

- a-One spinous
- b-Two transverse
- c- Four articular

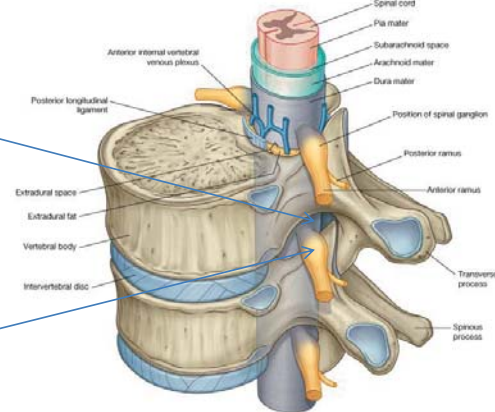
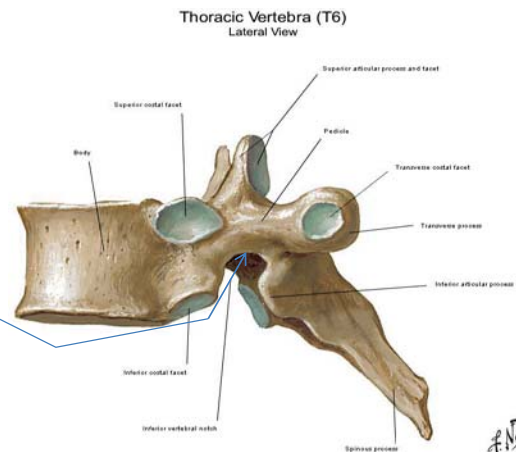


- ❖ The spinous process is directed posteriorly from the junction of the two laminae.
 - ❖ The transverse processes are directed laterally from the junction of the laminae and the pedicles
- The articular processes are vertically arranged and consist of:
- Two superior & Two inferior processes
- They arise from the junction of the laminae and the pedicles

❖ The pedicles
are notched on their
upper and lower borders
Forming
the superior and inferior
vertebral notches.

On each side
the superior notch of one
vertebra and the inferior
notch of an adjacent
vertebra together form an
intervertebral foramen.

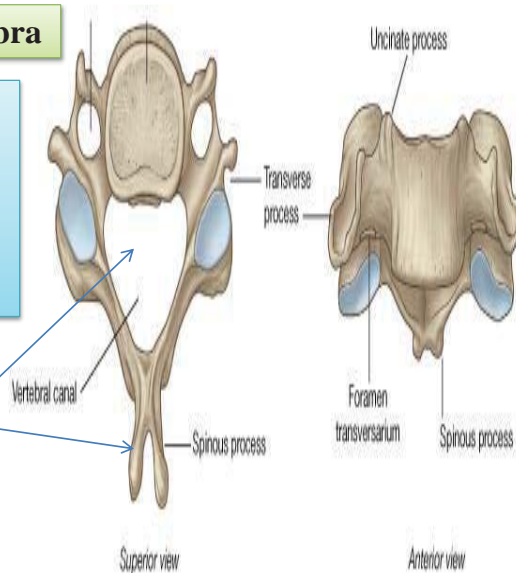
These foramina, in an
articulated skeleton, serve to
transmit the spinal nerves
and blood vessels.



Characteristics of a Typical Cervical Vertebra

➤ The transverse processes possess
a **foramen transversarium**
for the passage of the vertebral artery and veins
(note that the vertebral artery passes through the
transverse processes C1 to 6 and not through C7).

➤ The spines are small and **bifid**
➤ The vertebral foramen is large and **triangular**

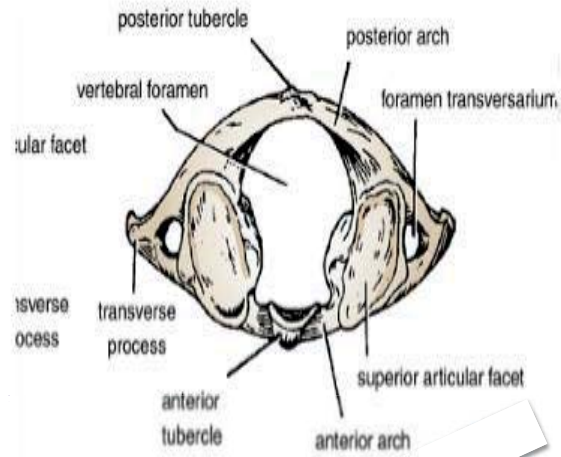


The first, second, and seventh cervical vertebrae are atypical.

The first cervical vertebra

THE ATLAS

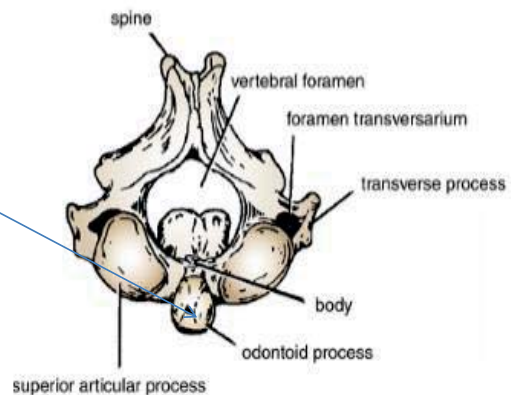
- does not possess a body or a spinous process
- It has an *anterior and posterior arch*
- It has a *lateral mass* on each side with articular surfaces on its upper surface for articulation with the **occipital condyles (atlanto-occipital joints)** and articular surfaces on its lower surface for articulation with the axis (**atlantoaxial joints**)



The second cervical vertebra

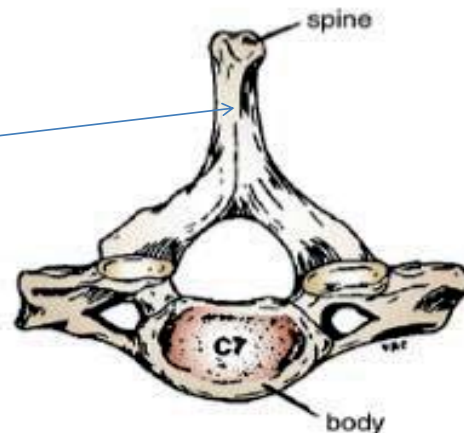
The AXIS

has a odontoid process that projects from the superior surface of the body (representing the body of the atlas that has fused with the body of the axis).



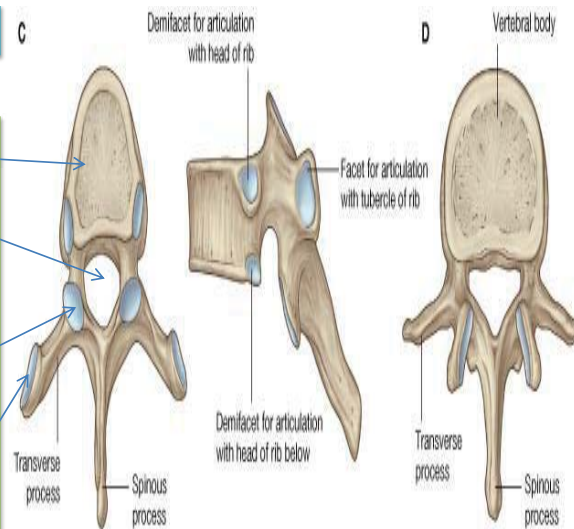
The seventh cervical vertebra

or vertebra **prominens** is so named because it has the **longest spinous process**, and the process is not bifid. The transverse process is large, but the foramen transversarium is small and transmits the vertebral vein



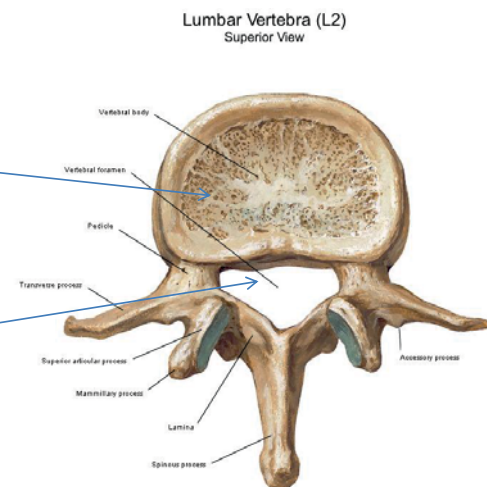
Characteristics of a Typical Thoracic Vertebra

- The body is **heart shaped**
- The vertebral foramen is small and **circular**
- The spines are **long and inclined downward**
- **Costal facets are present on the sides of the bodies for articulation with the heads of the ribs**
- **Costal facets are present on the transverse processes for articulation with the tubercles of the ribs**
(T11 and 12 have no facets on the transverse processes)



Characteristics of a Typical Lumbar Vertebra

- ❖ The body is large **and kidney shaped**
- ❖ The laminae are thick
- ❖ The vertebral foramina are triangular.
- ❖ The transverse processes are long and slender.
- ❖ The spinous processes are short, flat, and quadrangular and project backward.
- ❖ The articular surfaces of the superior articular processes face medially, and those of the inferior articular processes face laterally.



The sacrum

consists of five rudimentary vertebrae fused together

Articulations

1-The upper border, or base, of the bone articulates with **the fifth lumbar vertebra**

2-The narrow inferior border articulates with **the coccyx**.

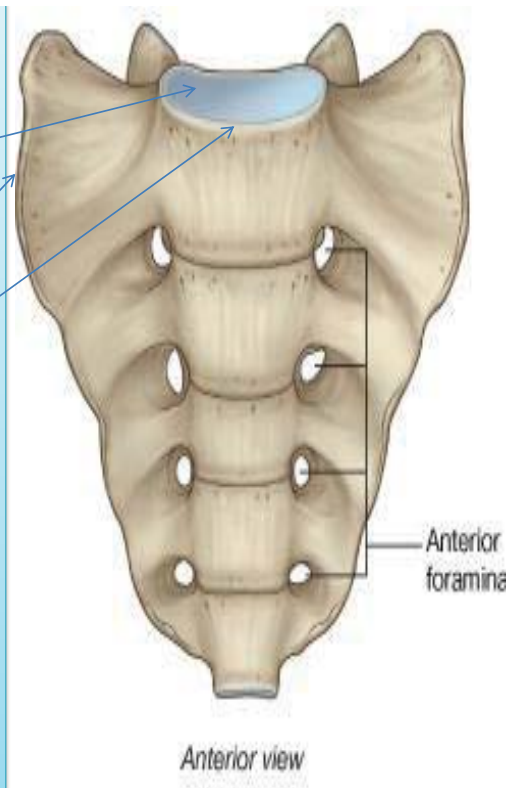
3-Laterally, the sacrum articulates with the two iliac bones to form the **sacroiliac joints**

The anterior and upper margin of the first sacral vertebra bulges forward and is known as the **sacral promontory**

➤The sacral promontory in the female is of considerable obstetric importance and is used when measuring the size of the pelvis.

The laminae of the fifth sacral vertebra, and sometimes those of the fourth also, fail to meet in the midline, forming **THE SACRAL HIATUS**

The anterior and posterior surfaces of the sacrum each have four foramina on each side for the passage of the anterior and posterior rami of the **sacral nerves**



COCCYX

The coccyx consists of four vertebrae fused together to form a single, small triangular bone that articulates at its base with the lower end of the sacrum

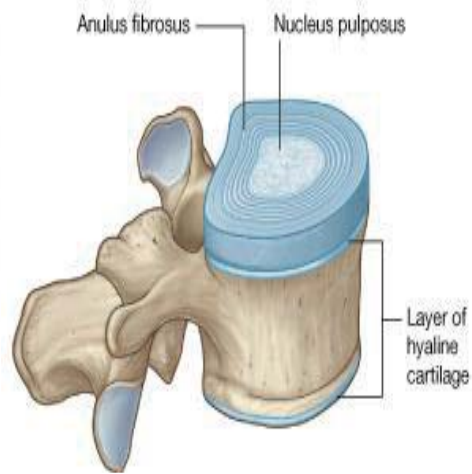
The first coccygeal vertebra is usually not fused or is incompletely fused with the second vertebra.

Intervertebral Discs

Their physical characteristics permit them to serve as shock absorbers when the load on the vertebral column is suddenly increased, as when one is jumping from a height.

Their elasticity allows the rigid vertebrae to move one on the other.

Unfortunately, their resilience is gradually lost with advancing age.

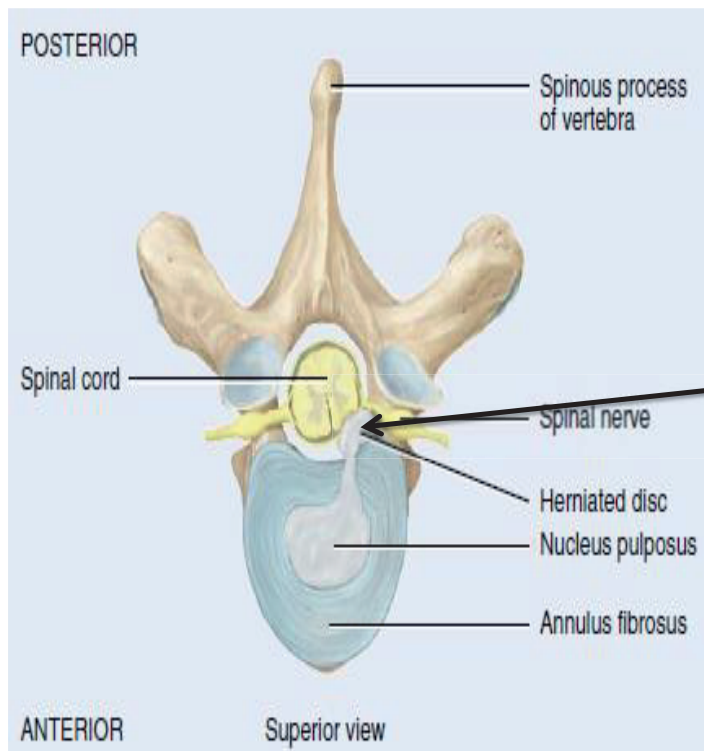


Each disc consists of a peripheral part, the **anulus fibrosus**, and a central part, the **nucleus pulposus**

The anulus fibrosus is composed of **FIBROCARTILAGE**, in which the collagen fibers are arranged in concentric layers or sheets.

The nucleus pulposus in children and adolescents is an ovoid mass of **gelatinous** material containing a large amount of water, a small number of collagen fibers, and a few cartilage cells.

It is normally under pressure and situated slightly nearer to the posterior than to the anterior margin of the disc.



The pressure developed in the nucleus pulposus may be great enough to rupture the surrounding fibrocartilage (annulus fibrosus). If this occurs, the nucleus pulposus may herniate (protrude) posteriorly or into one of the adjacent vertebral bodies. This condition is called a herniated

(slipped) disc?!

The disc usually slips posteriorly toward the **spinal cord and spinal nerves**.

This movement exerts pressure on the spinal nerves, causing **local weakness and acute pain**

Curves of the Vertebral Column

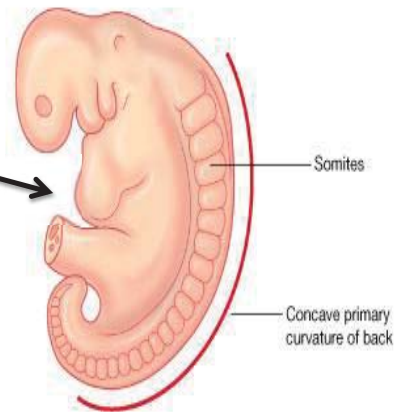
Curves in the Sagittal Plane

In the fetus,
the vertebral column has one continuous anterior
concavity

After birth,
when the child becomes able to raise his or her
head and keep it poised on the vertebral
column,
the cervical part of the vertebral column
becomes **concave posteriorly**

Toward the end of the first year,
when the child begins
to stand upright
the lumbar part of the vertebral column
becomes **concave posteriorly**.

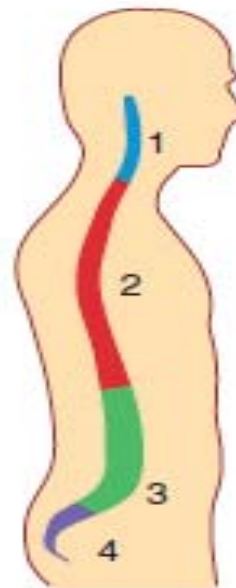
Early embryo



baby holds head up steadily
(3-4 months)



Single curve in fetus



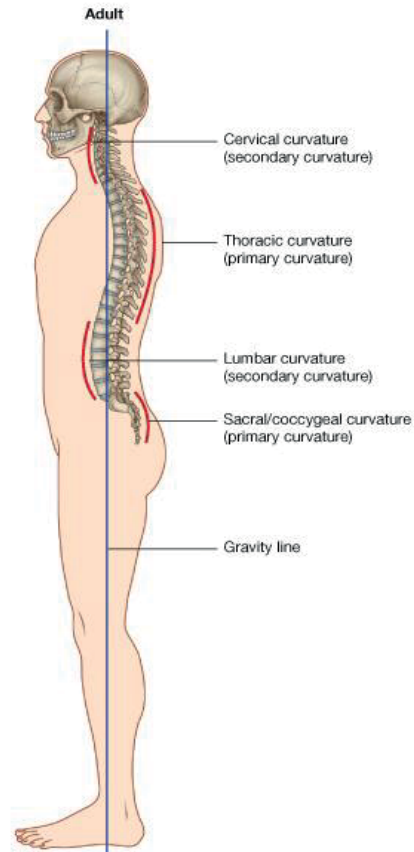
Four curves in adult



The development of these secondary curves is largely caused by modification in the shape of the intervertebral discs.

In the adult in the standing position the vertebral column therefore exhibits in the sagittal plane the **following regional curves:**

CERVICAL, posterior concavity
THORACIC, posterior convexity
LUMBAR, posterior concavity
SACRAL, posterior convexity



Abnormal Curves of the Vertebral Column

Kyphosis is an **exaggeration in the sagittal curvature** present in the **thoracic** part of the vertebral column.

It can be caused by muscular weakness or by structural changes in the vertebral bodies or by intervertebral discs.

Lordosis is an exaggeration in the sagittal curvature present in the **lumbar region**. Lordosis may be caused by an increase in the weight of the abdominal contents, as with the gravid uterus or a large ovarian tumor

Scoliosis is a lateral deviation of the vertebral column. This is most commonly found in the thoracic region and may be caused by muscular or vertebral defects

Abnormal Curves of the Vertebral Column

Various conditions may exaggerate the normal curves of the vertebral column, or the column may acquire a lateral bend, resulting in abnormal curves of the vertebral column.

Scoliosis :

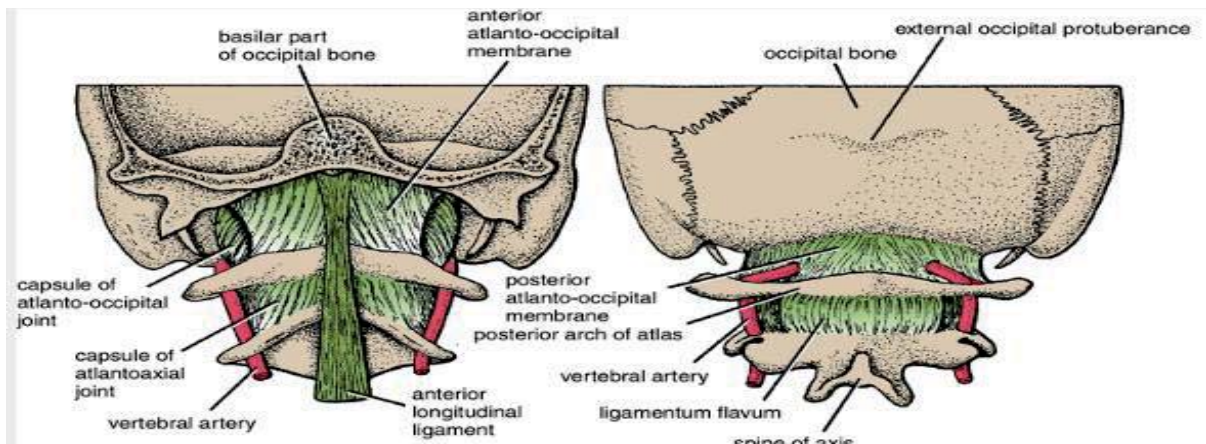
*the most common of the abnormal curves is a **lateral bending of the vertebral column**, usually in the **thoracic region***

Kyphosis : (hump)

Is an increase in the thoracic curve of the vertebral column

Lordosis : bent

backward is an increase in the lumbar curve of the vertebral column



Joints of the Vertebral Column

Atlanto-Occipital Joints

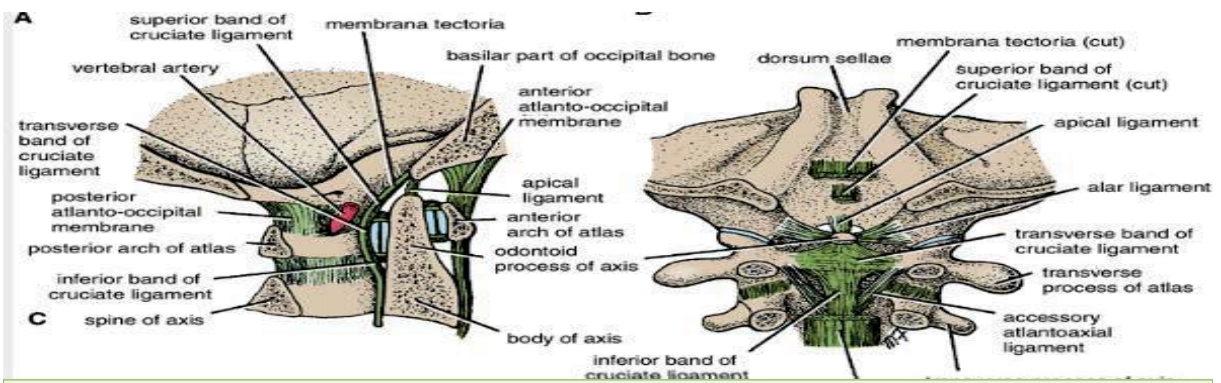
The atlanto-occipital joints are synovial joints that are formed between the occipital condyles, above the facets on the superior surfaces of the lateral masses of the atlas. They are enclosed by a capsule.

Ligaments

Anterior atlanto-occipital membrane
Posterior atlanto-occipital membrane

Movements

Flexion, extension, and lateral flexion. No rotation is possible



Atlantoaxial Joints

The atlantoaxial joints are three synovial joints:

one is between

the odontoid process and the anterior arch of the atlas

the other two are between the lateral masses of the bones

The joints are enclosed by capsules.

Ligaments

Apical ligament: connects the apex of the odontoid process to the anterior margin of the foramen magnum.

Alar ligaments:

Cruciate ligament: This ligament consists of a transverse part and a vertical part.

Membrana tectoria: This is an upward continuation of the posterior longitudinal ligament.

Movements

There can be extensive rotation of the atlas and thus of the head on the axis.

Joints Between Two Vertebral Bodies

The upper and lower surfaces of the bodies of adjacent vertebrae are covered by thin plates of hyaline cartilage. Sandwiched between the plates of hyaline cartilage is an intervertebral disc of fibrocartilage.

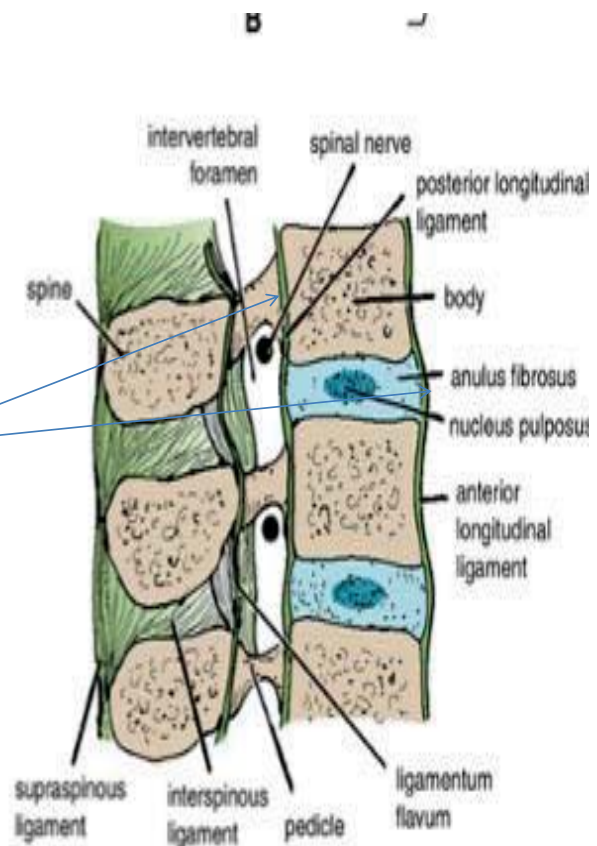
The collagen fibers of the disc strongly unite the bodies of the two vertebrae.

Ligaments

The anterior and posterior longitudinal ligaments

run as continuous bands down the anterior and posterior surfaces of the vertebral column from the skull to the sacrum

The anterior ligament is **wide and is strongly** attached to **the front and sides of the vertebral bodies** and to the intervertebral discs. The posterior ligament is **weak** and narrow and is attached to the posterior borders **of the discs**. These ligaments hold **the vertebrae firmly** together but at the same time **permit a small amount of movement** to take place between them.



Joins Between Two Vertebral Arches

The joints between two vertebral arches consist of synovial joints between the superior and inferior articular processes of adjacent vertebrae. The articular facets are covered with hyaline cartilage, and the joints are surrounded by a capsular ligament.

Ligaments

1-Supraspinous ligament:

This runs between the tips of adjacent spines.

2-Interspinous ligament:

This connects adjacent spines.

3-Intertransverse ligaments:

These run between adjacent transverse processes.

5-Ligamentum flavum:

This connects the laminae of adjacent vertebrae.

In the cervical region,

the supraspinous and interspinous ligaments are greatly thickened to form

the strong **ligamentum nuchae**.

The latter extends from the spine of the seventh cervical vertebra to the external occipital protuberance of the skull



Nerve Supply of Vertebral Joints

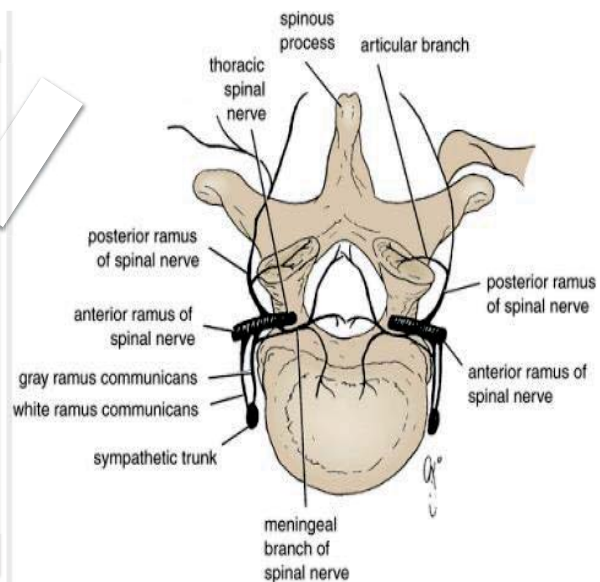
The joints between the vertebral bodies are innervated by

the small meningeal branches of each spinal nerve

The nerve arises from the spinal nerve as it *exits from the intervertebral foramen*.

It then re-enters the vertebral canal through the intervertebral foramen and supplies the **meninges, ligaments, and intervertebral discs**.

The joints between the articular processes are innervated by branches from **the posterior rami of the spinal nerves**



Muscles of the Back

The muscles of the back may be divided into **three groups**:

- 1-The superficial muscles:** connected with the shoulder girdle.
- 2-The intermediate muscles:** involved with movements of the thoracic cage.
- 3-The deep muscles or postvertebral muscles belonging to the vertebral column**

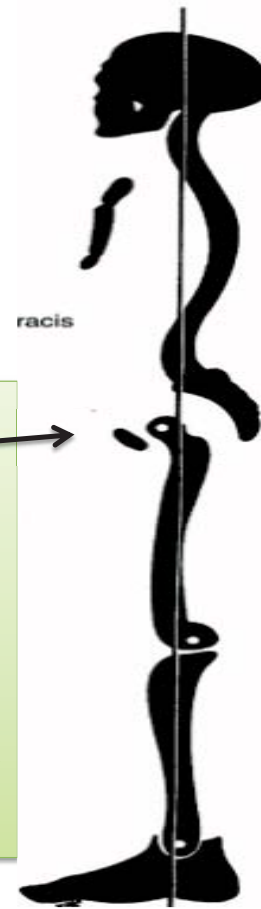
Deep Muscles of the Back (Postvertebral Muscles)

➤ In the standing position,

the line of gravity passes *through the odontoid process* of the axis,
behind the centers of the hip joints,
and in front of the knee and ankle joints
thus, greater part of the body weight falls
in front of the vertebral column.

It is, therefore, not surprising to find that the postvertebral muscles of the back are well developed in humans.

The postural tone of these muscles is the major factor responsible for the maintenance of the normal curves of the vertebral column.



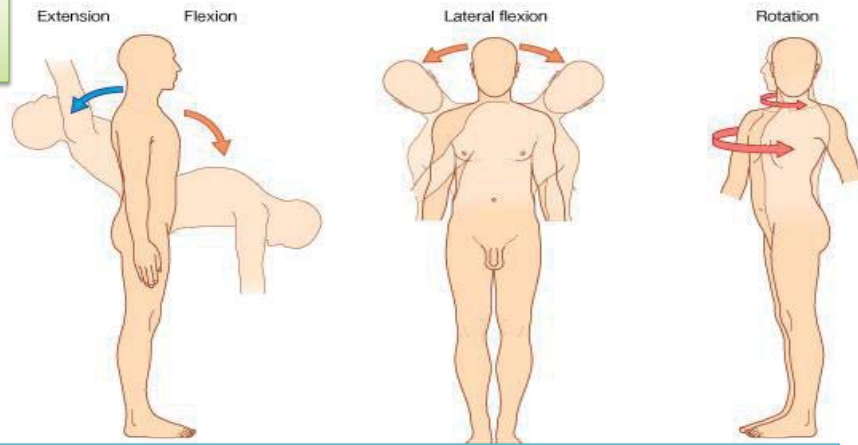
Superficial Vertically Running Muscles

Erector spinae muscle
Iliocostalis
Longissimus
spinalis

Intermediate Oblique Running Muscles
Transversospinalis:
SEMISPINALIS
MULTIFIDUS
ROTATORS

VERTEBRAL COLUMN MOVEMENT

The following movements are possible: flexion, extension, lateral flexion, rotation, and circumduction.



Flexion is a forward movement

Extension is a backward movement

Both are extensive ***in the cervical and lumbar regions*** but restricted in the thoracic region.

Lateral flexion is the bending of the body to one or the other side.

It is extensive in the cervical and lumbar regions but restricted in the thoracic region.

Rotation is a twisting of the vertebral column. This is least extensive in the **lumbar region**.

Circumduction is a combination of all these movements.